

IMPERIAL
DEPARTMENT OF AGRICULTURE
FOR THE WEST INDIES.



REPORT
ON THE
AGRICULTURAL DEPARTMENT,
DOMINICA.

1915-16.

BARBADOS:
ISSUED BY THE IMPERIAL COMMISSIONER OF AGRICULTURE
FOR THE WEST INDIES.

1916.

[Price Sixpence.]



REPORTS

ON THE

BOTANIC STATION, ECONOMIC PLOTS, AND AGRICULTURAL EDUCATION, DOMINICA.

Annual Reports on Certain Economic Experiments conducted in connexion with the Botanic Station, 1900-2.

Annual Reports on the Botanic Station for the years 1901 and 1902.

Annual Reports on the Botanic Station, Economic Experiments, and Agricultural Education for the years 1902-3 to 1913-14.

SUGAR-CANE EXPERIMENTS.

IN BARBADOS.

Report of the Agricultural Work for 1900 :—

Manurial Experiments and Experiments with Varieties of Sugar-cane.

Report of the Agricultural Work for the seasons 1899-1901 to 1908-10.

Parts I and II ; Manurial Experiments. Part III ; Varieties of Sugar-cane.

IN THE LEEWARD ISLANDS.

Report on Experiments conducted with Sugar-canes in the season 1899-1900.

Reports on Experiments conducted with Sugar-canes in the seasons 1900-1 to 1909-10.

Part I ; Varieties of Sugar-cane. Part II ; Manurial Experiments.

Sugar-cane Experiments in the Leeward Islands, 1911-12, 1913-14, and 1914-15.

Parts I and II published together in Royal 8vo.

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LETTER OF TRANSMITTAL.

Commissioner of Agriculture—to His Honour the Administrator, Dominica.

No. D. 2,387.

Barbados,

September 8, 1916.

Sir,

I have the honour to forward, herewith, the Annual Report on the Agricultural Department, Dominica, for the year ended March 31, 1916.

2. This Report records the accomplishment of a large amount of valuable work. Much of this, as for example, the work in the cacao and lime experiment stations and in the nurseries consists in a continuation of the work of the previous year. This continuity is essential to secure satisfactory results, and for the maintenance of progress.

3. Special interest attaches to the results obtained in the lime experiment Station where, each year, it is being more and more clearly demonstrated that as in the case of cacao, manuring is remunerative.

4. In spite of the fact that the climatic conditions during 1915 were unfavourable, the output of lime products was satisfactory. Planters would be well advised, however, to bear in mind that cacao and coco-nuts constitute valuable assets to the island, and their cultivation should not be neglected.

5. At the beginning of the year under review arrangements were completed for the reorganization of the chemical work in the Leeward Islands. The present report contains an account of the first year's chemical work in the Dominica laboratory. Useful investigations are recorded in connexion with lime products. A new line of study possessing special interest is that dealing with the concentration of lime juice by freezing. The intended enlargement of the laboratory should ensure good progress being made in the future.

6. The instruction of pupils at the Botanic Gardens continues to be carried on in a satisfactory manner. To show the nature of the field work done by the pupils, extracts from the diary of one of them are reproduced in the present publication, as well as the report on the work, by the Hon. J. C. Macintyre. These statements make it evident that the work done is of great practical value both to the pupils, and to the Presidency.

7. It will be noticed that the study of Dominica grasses and sedges has been continued, thanks to the kind assistance of the United States Department of Agriculture.

8. In conclusion I have to express my appreciation of the work that is being done by the Agricultural Department in Dominica. Every page in the present report is a concise account of work actually and usefully accomplished.

I have, etc.,

(Sgd.) FRANCIS WATTS,

Commissioner of Agriculture
for the West Indies.

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H. A. FRANK	...	...	...	...	Overseer.
E. B. JOSEPH	...	...	...	...	Clerical Assistant
					Agl. and Science Master.

REPORT ON THE AGRICULTURAL DEPARTMENT, DOMINICA,

For the Year ended March 31, 1916.

Work in the Gardens and Observations on Plants.

The routine work in the Gardens, Nurseries and Experiment Station was interrupted to a considerable extent by the severe storms which passed over the island on August 10, and September 22, respectively. In the Botanic Gardens, over 100 trees of considerable size were uprooted, but fortunately the experiment plots in the Gardens, which lie in a sheltered situation, and the new Experiment Station at Morne Bruce suffered no damage of importance.

A special grant was applied for and allowed by the Government, for the purpose of removing the fallen trees, and for pruning standing trees damaged by the force of the wind.

Owing to the system adopted of duplicating, whenever possible, the more interesting trees, the loss of species was very small, and at the time of writing nearly all have been replaced. Recent additions of new and interesting plants having been considerable, the year closed with a greater number of species under cultivation than at any previous period in the history of the Gardens.

The work of draining the Experiment Station was steadily proceeded with. Additional plantings of limes (both seedlings and budded plants) and of the best varieties of grape fruits were made. Approval having been given by authority for starting coco-nut experiment plots, an area of $2\frac{1}{2}$ acres was cleared, fenced, and planted. At the close of the year the work of draining and fencing an additional 2 acres for coco-nuts was in hand.

After many endeavours to obtain a plant of the handsome flowering tree of Burma (*Amherstia nobilis*), it is at last possible to report the successful importation of a specimen, which has made good growth and gives every promise of doing well under local conditions.

Towards the close of the year Mr. Fishlock, Manager of the Dominica Forest Company, forwarded to the Gardens herbarium specimens, in duplicate, of the leaves and flowers of eight forest trees of Dominica. These have been referred to the Kew authorities. Some help in the work of determining the botanical position of certain important forest trees was also furnished by Mr. G. Downing, of Lisdara, and Mr. A. S. Burleigh, of Sherwood.

In this connexion it is felt that if planters who are interested in this question would co-operate with the Agricultural Department, a good deal might be accomplished in the course of a few years in adding to our botanical knowledge of the trees of the island.

The first published list of Dominica trees appears to have been compiled by Dr. Inray, about the middle of the nineteenth century. With the help of several planters this list was revised about 1907, and published in the *West Indian Bulletin*, Vol. IX, pp. 329-45. Another careful revision is now needed. It is evident there are nothing like 176 species of timber trees growing in the island—the number given in the last list. It is now known that in a number of instances a single species appears in the list two or three times under different local names, thus La glu or Bois de Soie (*Sapium* sp.) also appears a second time under the name of Sagluie, and the Rosewood (*Cordia Gerascanthus*) turns up again as Laurier Cypre, and so on. A careful investigation on botanical lines is the only means of compiling an accurate list of our native trees.

The following have flowered in the Gardens for the first time :—

Baikea Eminii.
Bauhinia variegata.
 „ *purpurea*.
Cola Afzelii.
Detarium senegalense.
Spathelia simplex.

The following are amongst the interesting plants added to the collection during the year :—

<i>Antidesma bunius</i> .	<i>Sterculia platanifolia</i> .
<i>Caesalpinia asborea</i> .	<i>Terminalia edulis</i> .
<i>Cassia Sieberiana</i> .	„ <i>Arjuna</i> .
<i>Erythrina senegalensis</i> .	<i>Astrocaryum Ayri</i> .
<i>Ficus religiosa</i> .	<i>Metroxylon Sagus</i> .
<i>Hyphaene thebaica</i> .	<i>Macrozamia Denisoni</i> .
<i>Juniperus pachyphloea</i> .	<i>Phoenix Roebelini</i> .
<i>Peltophorum Linnaei</i> .	<i>Raphia pedunculata</i> .
<i>Parkia timoriana</i> .	<i>Zamia spiralis</i> .

Work in the Nurseries and Distribution of Plants.

The hope expressed some years ago that a local business would be formed which would take over a considerable portion of the nursery work now carried on by the Department remains unfulfilled.

From time to time efforts have been made by individuals to raise plants for sale, but those attempts have not lasted long. Nothing in the way of systematic and sustained work has been attempted. It is therefore likely that the maintenance of nurseries will remain, for some years at least, a departmental line of work.

The distribution of plants was below the average. This is due to development work on a number of estates having been arrested owing to the absence of a number of young planters, who, shortly after the outbreak of war, left the island in order to join His Majesty's Forces.

DISTRIBUTION OF ECONOMIC PLANTS.

The total number of plants sent out during the year was as follows:—

Limes	...	...	...	...	...	...	61,590
Budded Washington Navel oranges	...	...	...	...	...	...	62
„ grape fruit	...	...	...	...	...	...	188
„ lemons	...	...	...	...	...	...	16
„ limes	...	...	...	...	...	...	99
Grafted cacao	...	...	...	...	...	...	28
„ mangoes	...	...	...	...	...	...	55
Cacao	...	...	...	...	...	...	2,007
Coffee	...	...	...	...	...	...	500
Vanilla	...	...	...	...	...	...	25
Shade trees	...	...	...	...	...	...	785
Nutmegs	...	...	...	...	...	...	37
Camphor	...	...	...	...	...	...	56
Miscellaneous	...	...	...	...	...	...	252
Total							65,700

The following quantities of seed were sold:—

Vegetable	...	...	...	...	...	1,204 packets.
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Cuttings of the Nicaragua Shade tree (*Gliricidia maculata*), and seeds of several kinds of green dressings were distributed to planters free of charge.

PLANT IMPORTATIONS.

Twelve seeds of *Pouteria suavis*, a fruit tree of Uruguay, were received from the Kew Botanic Gardens. All the seeds germinated. Trials of this interesting species will be made in the Botanic Gardens, and in other districts of the island. It is described in the *Kew Bulletin*, No. 9, 1906, as being a splendid evergreen tree which bears a pear-shaped fruit having an extremely agreeable taste and possessing a finer scent than a ripe pine-apple.

Two plants of the Jaboticaba (*Myrciaria cauliflora*) were received from the United States Department of Agriculture, in exchange for seeds of the Mangosteen (*Garcinia Mangostana*). It is hoped that this, the favourite fruit tree of the Brazilians, will be found to succeed in Dominica. Mr. Wilson Popenoe, of the United States Department of Agriculture, writes of this tree as follows: 'Among the many interesting indigenous fruits of Central and Southern Brazil, few create so strong an impression on the new comer as the Jaboticaba, not only because of its habit of producing its delicious fruit upon the trunk of the tree from the ground, but also because of the unusual beauty of its symmetrical, dense, umbrageous head of light-green foliage, which entitles it to a place among the best ornamental trees of the region.'

To the collection of mango trees were added the varieties Haden and Mulgoba, which were obtained from the United States Department of Agriculture. Both are considered first rate kinds, and it was desirable to import them for testing alongside selected Indian varieties already growing in Dominica.

As a result of the investigation now being made at Kew in connexion with the species of *Achras* which yield Chicle gum, seeds of an *Achras* from British Honduras were received through the Commissioner of Agriculture, and about 200 plants were raised. The value of the importation was at a later date somewhat discounted by the receipt of information showing that the seeds had been taken from young trees which had not been bled. It is intended, however, to grow a number of the seedlings for comparison with the common *Achras* of the West Indian islands. Meanwhile, now that it is known more than one species yield Chicle gum, further steps are being taken to obtain seeds of the kind known to yield the best quality gum.

GREEN DRESSING TRIALS.

A single plant of the Queensland nut (*Macadamia ternifolia*) was raised from seeds received from the Botanic Gardens, Trinidad, during 1914. This has been planted out for trial.

No success has attended the efforts to establish the Brazil nut (*Bertholetia excelsa*), in spite of repeated trials extending over a number of years. Recently a further supply of seeds has been received, and fresh attempts will be made to grow this tree. A similar difficulty has been experienced with the Sapucaia nut (*Lecythis Zabucajo*).

The two trees of the Litchi (*Nephelium Litchi*), a species introduced sixteen years ago, grow well, but fruit only at intervals of five or six years. Other species of this genus which yield edible fruit are desired for the Garden collection.

Plot Experiments at the Botanic and Experiment Stations.

GREEN DRESSING TRIALS IN DOMINICA.

Reference to previous reports will show that during the last few years a large number of plants have been tried at the Experiment Station, with the view of finding out those that are most likely to prove of value under Dominica conditions.

Below will be found a list of some of those experimented with :—

Horse bean	(<i>Canavalia ensiformis</i>)
	" <i>gladiata</i>
<i>Tephrosia</i>	<i>candida</i>
"	<i>Hookeriana</i> , var. <i>amœna</i>
"	<i>Vogelii</i>
<i>Indigofera</i>	<i>suffruticosa</i>
"	<i>Anil.</i>
Jerusalem pea	(<i>Phaseolus trinervis</i>)
Chick pea	(<i>Cicer arietinum</i>)
Cluster bean	(<i>Cyamopsis Psoraloides</i>)
Bengal "	(<i>Stizolobium aterrimum</i>)
Lyon "	" <i>niveum</i>
Pigeon pea	(<i>Cajanus indicus</i>)
<i>Clitoria</i>	<i>cajanifolia</i>
Soy beans	(<i>Glycine hispida</i>)
Rounceval pea	(<i>Vigna unguiculata</i>)

With two or three exceptions the various species grew well, producing a large quantity of green material. Those that after years of experience have shown to give the best results are :—

The Horse bean	(<i>Canavalia ensiformis</i>)
<i>Tephrosia</i>	<i>candida</i>
"	<i>Hookeriana</i> , var. <i>amœna</i>
Bengal bean	(<i>Stizolobium aterrimum</i>)
Pigeon pea	(<i>Cajanus indicus</i>)

Canavalia ensiformis, the horse bean, is the best all-round cover that we have. The seed is large and germinates readily. Planted at the beginning of the wet season it keeps on growing for four to six months, covering the ground with a low (2 to 3 feet) undergrowth which keeps the soil free of weeds. The plants form a large number of root nodules, thus adding to the soil a very considerable quantity of nitrogen; and on decaying, the foliage forms valuable mulching material. They may be sown in rows 3 feet apart and about 6 inches apart in the row. They will require to be weeded once or twice. The plant is a weak climber.

GREEN DRESSINGS.

Tephrosia candida has been under cultivation for several years and can be strongly recommended. The seeds, however, are very small and should be sown with the rains; the plants need careful nursing in the early stages; they must not be sown too deeply. Once established, they grow 6 to 7 feet high and keep the ground free of weeds for about two years.

Tephrosia Hookeriana, var. *amœna*, similar to former, but grows to a height of 2 to 3 feet.

Stizolobium aterrimum, commonly known as the Bengal bean, whilst forming a dense growth and a large quantity of green manure, and keeping the ground clean for a lengthy period, cannot, owing to its strong vine-like growth, be grown amongst trees such as limes, cacao and coco-nuts, unless care is taken to keep the vines cut back from the trees at intervals. If this precaution be taken, then several species of *Stizolobium* could be employed for the production of mulch.

Cajanus indicus, the pigeon pea, is so well known that no description need be given of its cultivation and habit of growth.

In spite of the efforts which have been made by the Department, by example and in other ways, to popularize the growing of green dressings, it cannot be said that the practice has been taken up on estates to any considerable extent. With one or two exceptions, the growing of green dressings never enters into estate practice in Dominica. This is to be regretted, for it is recognized as being one of the chief methods of improving the condition of the soil. With the heavy rainfall and the action of the hot tropical sun, the decay of humus in the soil is rapid, and needs continuous replacing if the fertility of the soil is to be maintained and increased. Furthermore, the growing of green dressings would prevent to a large extent the wash of surface soil which is to be seen going on all over the island, and would also add materially to the nitrogen content of the soil.

On the other hand, established lime fields in Dominica are so covered in, that but very little vegetation will grow under the shade of the trees, and furthermore, even if they did, there would be the difficulty of picking up the lime crop. Under these circumstances, it is necessary to procure plant food from outside. Whether, under these conditions, it would be remunerative to grow crops on waste land to be carried on to the fields at the right season, has not yet been demonstrated. Efforts to solve this problem are being made at the Lime experiment station, where ravines and such places are planted up with lemon grass (*Cymbopogon citratus*) and the Nicaragua shade tree (*Gliricidia maculata*). Data as to the tonnage per acre obtainable from such places with these plants may be available in a year or two. There are acres of such land on most estates in Dominica which could be utilized for this purpose.

The above remarks on green dressings hold good, therefore, only in young cultivation, and when the trees are widely planted and have not yet filled in.

Notes on Economic Plants.

CASTILLOA ELASTICA.

A number of *Castilloa elastica* rubber trees growing in the Botanic Gardens were systematically tapped from April 1911 to April 1915—a period of four years. Arrangements had been made to have these trees tapped for a considerably longer period, but unfortunately, the gale of August last destroyed such a large number of the trees that were being experimented with, that it would have been of little use continuing the tapping operations on the few remaining. It was therefore necessary to bring this experiment to a close, and the remaining trees which were growing in and shading the cacao at the experiment station have since been removed.

COFFEE AND CACAO.

The experiments in question have established the fact that, under Dominica conditions, *Castilloa elastica* cannot be regarded as of any economic importance as a rubber-producing plant. Whilst in many localities the tree itself grows well and remains healthy, the amount of rubber obtained is so small that it fails to yield a profit.

Taking the four best grown trees in the Gardens—they were twenty-three years old, had not been previously systematically tapped, and had an average girth measurement of 7 feet 9 inches at 3 feet from the ground—the yield of rubber was, on an average, only 8 oz. of cured rubber per tree per annum.

COFFEA ROBUSTA.

In October 1901, a wardian case containing 100 plants of *Coffea robusta* was imported from Messrs. Linden, Brussels. At a later date some doubt arose regarding the correctness of the naming of this coffee. This led to botanical specimens being submitted to Kew Botanic Gardens, at which institution the coffee was identified as *Coffea robusta*, Linden.

A small plot of this species has been grown at the Gardens since its introduction. The plants thrive well, are good yielders, and the produce is of a high class. Up to the present there has been very little local demand for either plants or seeds.

Under present conditions it is too much to expect anything like extensive planting of coffee, but there is no reason why both planters and peasants should not grow this species on a small scale for the purpose of meeting the local demand for coffee, the island's production of which is, unfortunately, steadily declining.

CACAO.

GRAFTED CACAO.

The following table gives the results of the observations to June 30, 1916, in respect to the grafted cacao plots:—

GRAFTED CACAO PLOTS.

Date of planting.	No. of trees planted.	Last date of picking.	No. of bearing trees.	Total annual yield in pods.	Yield per tree in pods.
Plot No. 1.					
July 1906 ...	14	June 30, 1908	14	12	0·8
„ 1907 ...	14	„ 1909	14	237	16·9
		„ 1910	28	860	30·7
		„ 1911	28	1,382	49·3
		„ 1912	28	1,365	48·7
		„ 1913	28	1,274	45·5
		„ 1914	28	2,360	84·3
		„ 1915	28	3,528	126
		„ 1916	28	2,702	96·5

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GRAFTED CACAO.

GRAFTED CACAO PLOTS.—(Concluded).

Date of planting.	No. of trees planted.	Last date of picking.	No. of bearing trees.	Total annual yield in pods.	Yield per tree in pods.
Plot No. 2.					
July 1907 ...	35	June 30, 1910	35	191	5.4
„ 1908 ...	17	„ 1911	52	893	17.1
		„ 1912	52	3,466	66.6
		„ 1913	52	6,466	124.3
		„ 1914	52	7,782	149.6
		„ 1915	42	3,579	85.2
		„ 1916	42	4,038	96.1
Plot No. 3.					
July 1910 ...	30	June 30, 1914	30	713	23.7
		„ 1915	30	1,239	41.3
		„ 1916	30	1,763	58.7

The twenty-eight trees in plot No 1, fourteen of which are of a Criollo variety, and fourteen of a Forastero type, were originally planted amongst orange trees. Under these conditions the maximum crop was reached during 1911. In 1912-13 the yield began to fall off. The orange trees were thinned during 1912, and all were removed during 1913. The two succeeding years showed a considerable increase of crop, but during the year under review, owing probably to the excessive rains and high winds, there was a falling off in the yield.

The Forastero trees in plot No. 2, planted at distances of 12 feet x 12 feet, were severely attacked by root grubs during 1914. Remedial measures consisted of an application of carbon bisulphide emulsion as described in the *Agricultural News*, Vol. XIII, p. 202, and the applying of manures. Under this treatment the trees appear to have thrown off the attack. They are now looking healthier, and there has been a small increase of crop.

Plot No. 3 consists of thirty trees of a Forastero variety, planted at 20 feet x 20 feet, amongst seedling orange trees. As the cacao trees increase in size the orange trees are being gradually removed.

DOMINICA GRASSES.

In the progress report for 1913-14, a list was given of the Dominica grasses collected during the year. Inadvertently the names of the authorities were omitted. During the last two years, nine additional species were collected, and those not known locally were determined by Mr. Hitchcock, of the United States Department of Agriculture, and the full list is now reproduced. Following the list of grasses appears a list of some species of sedges which were also forwarded to Mr. Hitchcock, and named by Mr. P. B. Stanley :—

IDENTIFICATION OF GRASSES AND SEDGES.

DOMINICA GRASSES.

Andropogon brevifolius, Sw.	Leptochloa virgata, (L) Beauv.
" condensatus, H.B.K.	Melinis minutiflora, Beauv.
" pertusus, Willd.	Oplismenus hirtellus, (L) R. & S.
Anthephora hermaphrodita, (L) Ktze.	" loliaceus, Beauv.
Arundinella martinicensis, Trin.	Panicum (chaetochloa) barbatum, Lam.
Axonopus compressus, Beauv.	" barbinode, Trin.
Bouteloua americana, Scribn.	" laxum, Sw.
Capriola dactylon, (L) Ktze.	" maximum, Jacq.
Cenchrus viridis, Spr.	" palmifolium, Willd.
Chaetochloa glauca, (L) Scribn.	" pilosum, Sw.
Chloris paraguayensis, Steud.	" trichoides, Sw.
" radiata, (L) Sw.	Paspalum conjugatum, Berg.
Coix lachryma, Linn.	" fimbriatum, H.B.K.
Cymbopogon citratus, Stapf.	" Helleri, Nash.
" Nardus, Rendle.	" paniculatum, L.
" Schoenanthus, Spreng.	" pumilum, Nees.
Dactyloctenium aegyptium, (L) Richt.	Pennisetum setosum Rich.
Echinochloa colonum, (L) Link.	Setaria brachiata, (Poir.) Kth.
Eleusine indica, (L) Gaertn.	Sporobolus jacquemontii, Kth.
Eragrostis ciliaris, (L) Link.	Stenotaphrum secundatum, (Walt.) Ktze
" delicatula, Trin.	Thysanolaena agrostis, Roxb.
" tephrosanthes, (Spreng.) Schult.	Syntherisma digitata, (L) Hitchc.
Erichloa punctata, (L) W. Hamilt.	Valota insularis, (L) Chase
Isachne disperma, (Lam.) Doell.	Vetiveria zizanioides, (L) Nash (Andro-
Ischaemum latifolium, (Spreng) Kunth.	pogon squarrosus, L f).
Lasiacis, n. sp., (Previously Panicum	
divaricatum.)	

DOMINICA SEDGES.

Cyperus compressus, L.
" filiculmis, Vahl.
Fimbristylis polymorpha, Boeche.
" autumnalis, R. & S. ?
Kyllinga pumila, Michx.
Rynchospora polyphylla, Vahl.
Scleria melaleuca, Schlecht. & Chamis.

CROPS AT THE GARDENS.

The cacao crop for the year ended June 30, 1916, was 83 $\frac{1}{4}$ cwt.—a slight decrease of $\frac{3}{4}$ -cwt. when compared with that of the previous period.

The yield of the cacao cultivation, which is estimated at 7 $\frac{1}{2}$ acres, was 9,328 lb., equivalent to 46 $\frac{1}{2}$ bags of a standard weight of 200 lb. each.

The crops gathered for the past five years are as follows :—

Year ended June, 1912	...	...	81 $\frac{1}{2}$ cwt.
" " " 1913	...	...	88 $\frac{1}{2}$ "
" " " 1914	..	...	74 $\frac{1}{2}$ "
" " " 1915	...	...	84 "
" " " 1916	...	...	83 $\frac{1}{4}$ "

The rainfall for the year ended June 30, 1916, was 94.10 inches.

Three bags of kola nuts, of a total weight of 661 lb., and 2 bags of nutmegs, of a total weight of 346 lb. were shipped to London.

There were also sold locally, 313 barrels of ripe limes and a considerable quantity of mangoes, oranges, tangerines, and grape fruits.

PROGRESS IN THE CHIEF INDUSTRIES.

LIME INDUSTRY.

GENERAL CONDITIONS.

The crop for 1915, calculated in barrels of an average capacity of 4.55 cubic feet, amounted to 390,458 barrels or 2,447 over the crop of 1914, and only 749 below the record crop of 1913. It is evident that had the weather conditions been normal during 1915, a considerable advance in the crop output would have resulted.

The lime crop for the past seven years, calculated in barrels of fruit, is recorded below :—

1909	...	...	284,000 barrels.
1910	...	...	369,000 "
1911	...	...	355,000 "
1912	...	...	370,000 "
1913	...	...	391,000 "
1914	...	...	388,000 "
1915	...	...	390,000 "

The following table, calculated on the usual basis,* shows the disposal of the crop under the various heads :—

Product.	Barrels of fruit.	Approximate percentage of total crop.
Concentrated juice	229,938	59
Raw juice	103,608	26.5
Fresh limes	41,494	10.5
Citrate of lime	14,656	3.5

Comparison with last year's disposal of crop shows that owing to market conditions considerable changes may occur annually under the various heads. During 1915, concentrated juice and fresh limes practically maintained the same position as in the former year. There was, however, a considerable advance under raw juice, the percentage rising from 13 to 26.5. On the other hand, the export of citrate of lime fell from 18 per cent. to 3.5 per cent.

The falling off in the production of the last named was foreshadowed in the progress report for 1914. It is due partly to the existing great demand for raw juice, and partly to the preference at present given to the production of high grade concentrated juice by means of steam-heated evaporators.

The business in connexion with pickled limes and lime juice cordial continued on the usual small scale, the total requirements under the two heads being 762 barrels.

The climatic conditions during 1915 were distinctly unfavourable. After a period of twelve years, during which there was an absence of bad weather during the hurricane seasons, a heavy storm broke over the island on August 10, which

* Note.—50 gallons of concentrated juice equals 75 barrels of lime fruits : 7½ gallons of raw juice equals 1 barrel of lime fruits : 1 ton of citrate of lime equals 266 barrels of lime fruits.

caused considerable damage to lime cultivation, and affected crop prospects, particularly on estates exposed to the south-west. The damage can only be approximately computed, but it is probable that from 10,000 to 12,000 trees were blown over, and that from 14,000 to 15,000 barrels of fruit were lost owing to the falling of immature fruit. On a few of the large estates the loss was covered by insurance.

In regard to fallen trees, it is important to state that a lime tree blown over is not necessarily a tree lost. The proportion of loss in respect to fallen trees may not exceed 2 or 3 per cent. in some cases, in others 5 per cent., whilst a loss of 10 per cent. under average conditions would be regarded as very high. The question of loss is clearly connected with the amount of displacement of the roots of individual trees. A good deal depends on an accurate survey of the situation by planters, and on the adoption of measures best suited to meet the varying conditions of injury.

In addition to the damage caused by the wind, the proportion of crop carried away owing to torrential rains was higher than during an average season. The heavy downpours in a normal year cause a considerable loss of ripe limes, which are washed into drains and ravines and from these to the streams and rivers. During a year of excessive rains, like the period under review, the loss under this head is correspondingly increased.

For some years past root disease of lime trees on newly opened estates in forest districts has caused much concern. This matter has been closely investigated by the Mycologist of the Imperial Department, who paid two visits to Dominica for this purpose. His conclusions were embodied in a Departmental pamphlet, copies of which were distributed free to planters. Now the cause is understood, measures as recommended are being taken on the estates concerned with promising results. Altogether the outlook in this connexion is more hopeful, and the situation better in hand than at any previous time.

The position in regard to attacks of scale insects showed no change. On established lime trees these pests were, on the whole, effectively controlled by insect and fungus parasites. Lime cultivation in the course of being established, especially in the coastal zone, is always liable to severe attacks of scales, which greatly delay the maturity and fruiting of the trees. Draining, the application of manures, and, where required, the provision of wind-belts, are necessary to enable the trees to withstand and overcome the attacks. Once the trees are established the danger of infestation by scale insects is greatly lessened.

The value of fertilizers imported during 1915 was £5,337, an increase of £1,275 over the figures of the previous year. The amount of manure imported is still far from meeting the requirements of lime cultivation, especially when it is clear that every little expenditure is incurred on the majority of estates in the production of pen manures and mulches. It is estimated that after allowing for the production of considerable quantities of pen manure, an annual importation of fertilizers, of a value of £15,000, is necessary for lime cultivation alone.

It may be argued that in a country like Dominica, it is economically unsound to import fertilizers, and that it would be a better policy to spend the money locally on the production of pen manures and mulches, and for the utilization of lime skins and seeds for manurial purposes. That argument cannot be refuted. The spending of so considerable a sum on labour and feeding stuffs in the local production of organic manures and their application to lime fields, would result in greater and more lasting benefits to planters than those obtainable by the use of imported concentrated manures. Unfortunately there is little probability of the adoption of so sound a policy. The tendency at present is for estates to keep as few animals as possible. Pens do not exist on many estates. Where they do exist, they are, in the majority of instances, not utilized. On a number of estates neither pen or special manure is applied; on others, manures are only applied when the foliage of the trees is yellowish in colour and fruiting has practically ceased. Only on a few estates is a sound manurial system in existence.

How long these methods, which are so lacking in sound agricultural practice, will enable the planters concerned to continue, is a matter for serious reflection. It

LIME JUICES.

is feared that the low rate of production per acre, the heavy loss owing to general inefficiency of lime mills, the wasteful system of manufacture, coupled with over-concentration of the juice, and the consequent heavy loss of acid, will not allow planters to meet the competition of other countries, which already looms in the distance, unless there is a general improvement in the methods of producing concentrated lime juice, which forms 59 per cent. of the industry, and an uplifting of the present low standard of agricultural practice in lime fields.

LIME JUICES.

Concentrated juice.—The quantity shipped was 153,292 gallons, or 5,113 gallons in excess of the shipments during 1914.

In this connexion the chief feature of the year has been the installation on several large estates of steam-heated evaporators for the purpose of concentrating juice.

It is hoped that this step will be generally followed on all estates with considerable producing capacity, as it puts an end to large losses of acid, and with care allows of the production of a high grade juice.

The amount of high grade concentrated juice exported is by no means large. Taking the annual production at 3,000 hogsheads of 50 gallons each, it is probable that not more than one-fourth of the amount would rank as clean, well prepared juice. Still a good deal of progress has been made recently in this respect. Only a few years ago, no clean juice, as the term is understood to-day, was exported from the island.

Now that high grade juice is in demand, there are indications that the market will discriminate in its favour and that inferior grades will be penalized by lower prices. Pressure in the shape of lower market prices would be the best means of bringing about a much needed improvement, and in removing what has for some time been a reproach against Dominican producers.

While the system of concentrating by steam is the best and most economical known, the loss of acid not exceeding 3 per cent., it must not be thought that clean, well prepared juice cannot be produced in copper tayches over open fires. On the contrary, it has been shown that a high class article can be prepared in a properly arranged battery if attention is paid to settling the juice, to skimming during boiling, and by careful manipulation of the fire. The loss of acid is much higher over the open fire than in steam evaporators, but by the exercise of care this loss has been brought down to 8.5 per cent. on a moderate concentration.

Raw Juice.—The export of this article more than doubled that of the previous year, and reached a total of 777,064 gallons. No less than 635,881 gallons were shipped to the United Kingdom, 76,696 gallons to Canada, and 64,487 gallons to other countries.

The increase in the export of raw juice was due to the need of large supplies for the use of the British Navy, and for the armies of the allied nations.

CITRATE OF LIME.

The export of this product was 1,102 cwt. against an output of 5,191 cwt. during the previous year. As previously explained, this falling off was due to the great demand for raw lime juice, and to the preference now given to the manufacture of concentrated juice by means of steam evaporators.

FRESH LIMES.

There was a falling off in the shipments of fresh limes to the extent of 3,789 barrels, the total number of barrels exported being 41,494 against 45,283 during 1914. In spite of decreased shipments, this branch of the lime industry remains in a sound and profitable condition.

VALUE OF LIME EXPORTS.

Correspondence between the leading shippers of fresh limes and the Quebec Steamship Company on the subject of better provision on the Company's steamers for fruit shipments was published in the *Official Gazette* of March 27, 1916. The agents of the Company in reply to the petitioners, expressed a desire to meet the wishes of shippers to the fullest extent, but pointed out that while most shipments of limes from Dominica were carefully picked and packed, others consisted of badly picked inferior fruit, carelessly packed in ill-coppered packages. This defect was especially pronounced at a time when market rates ruled high in New York. No effort on their part, the Company added, could meet this phase of the situation.

The shipment of inferior badly packed fruit by speculators is always a drawback and a danger in the early stages of a developing and profitable fruit trade. It remains to be seen whether means can be devised in Dominica for dealing with this situation.

LIME OILS.

The total value of lime oils shipped during 1915 was returned as £12,469, an increase in value of £2,331 over the exports of the previous year.

A feature of the market has been the great demand and the high prices paid for distilled lime oil. The market price for this product, which in normal times averages 2s. to 2s. 6d. per lb., advanced to 10s. per lb. at the end of March 1916.

The output of both distilled and handpressed oils was below the average. The shortage was largely due to the great demand for raw lime juice for making beverages. Local buyers of raw juice endeavour, as far as possible, to obtain their supplies from unécuelled limes so as to secure with the juice as large a supply of oil as possible; the chief reason for this being that lime oil is the best preservative of the raw juice.

The exports of lime products during 1915 were as follows:—

Product.	Quantity.	Value.
Concentrated lime juice	153,192 gallons	£ 53,469
Raw lime juice	777,064 „	55,276
Raw juice cordial	5,950 „	891
Green limes	41,494 barrels	48,026
Pickled limes	524 „	524
Citrate of lime	1,102 cwt.	3,749
Essential oil of limes	4,108 gallons	9,985
Otto of limes	974 „	2,484
		£174,404

Compared with the previous year, there was a total decrease in value amounting to £12,626.

MINOR PRODUCTS.

CACAO.

After a gradual decrease in the exports of cacao during 1913 and 1914, there was an improvement during 1915 when the exports totalled 10,810 cwt. It is probable that the increase was largely due to a carry over at the end of 1914, as the climatic conditions were distinctly unfavourable for cacao during 1915. The falling off in this crop is a real one. Taking the three-year period 1910-12, the annual export of cacao averaged 11,068 cwt. During the three-year period 1913-15, the annual shipments fell to 9,748 cwt.—a very considerable fall in a small industry.

Planters in possession of land suitable for cacao would be well advised to plant areas in this product for the purpose of securing to Dominica a continuance of what is, after the lime industry, our only agricultural asset of importance.

COCO-NUTS.

The shipments of coco-nuts have averaged for the past four years a little over half a million nuts yearly. As the local consumption is considerable, it is probable that the annual production of nuts is over the million mark.

Some progress has been made of late in the planting of new areas. In the Lasoye district, it is estimated that about 500 acres have been placed under this cultivation during the past three years. Planting in other districts appears to have been on a smaller scale.

Considering how completely dependent Dominica is upon lime cultivation, it is important that measures should be taken in the direction of developing new agricultural interests in case of failure or set-back of the major industry.

In this connexion authority was given by His Honour the Administrator to start coco-nut plots at the Experiment Station. At the close of the year over 4 acres of land, divided into thirteen plots, had been drained, fenced, and planted. It is hoped to add to this area, in order to carry on cultural and manurial experiments for the lime and cacao industries.

MINOR PRODUCTS.

The quantities and values of minor products exported during 1915 are given below:—

Produce.	Quantities	Values.
		£
Oranges	865 barrels	673
Orange oil	46 gallons	92
Bay leaves	503 cwt.	423
Bay oil	136 gallons	387
Bananas	2,225 bunches	111
Starches	214 cwt.	200
Coffee	30 „	127
Hardwood	43,839 feet	245

REPORT ON MANURIAL EXPERIMENTS.

I. LIMES.

A series of manurial experiments in connexion with lime cultivation was laid out in the valley beyond Morne Bruce in the early months of the year 1913. The experiments may be divided into two series :—

Series 1—with old lime trees which existed on the plots when the experiment was laid out.

Series 2—with young lime trees only planted in July 1913.

SERIES I. WITH OLD TREES.

The condition of the lime trees constituting series 1, when the experiment was commenced in January 1913, may be gathered from the following description taken from previous reports and reproduced here for ease of reference:—

‘The limes in question were planted during 1893 by the boys of the Reformatory School, a Government institution which existed at Morne Bruce from January 1893 to December 1895. To the end of the latter year the plants were cared for, but from that time to the present the land has remained in bush, amongst which the limes have struggled to exist. On the bush being removed, the lime plants were found, as expected, to be poor in condition and attenuated in appearance. With attention, these poor limes should develop in the course of time into healthy well-shaped trees.

‘It is to be expected, under the condition stated above, that the plots are not complete. Vacancies occur in each, which will be filled in as soon as possible.

‘The land occupied by the plots is sloping in character, conditions typical of large areas of lime cultivation in the island.’

On the whole, these trees continue to make satisfactory progress, and a good growth of new wood was general throughout the plots. The trees continue free from attacks of scale insects; a few were blown over by the storm of August last, but, on the whole, the lime experiment station was not seriously damaged.

The area of existing lime trees was sufficient to allow of eight plots, of approximately $\frac{1}{4}$ -acre each, to be started.

Each plot received its first quatum of manure in July 1913. In May 1914 and May 1915 similar applications were given, and it is intended to make identical applications in May-June of each year for a number of years. The limes from each plot were collected and measured throughout the year, necessitating no less than fifty-eight pickings.

The following table shows the annual manurial treatment that each plot has received, and the number of standard barrels, of $4\frac{1}{2}$ cubic feet capacity, which were picked from each plot, and their equivalent per acre :—

RESULTS OF MANURIAL EXPERIMENTS WITH LIMES.

Year ending March 31.	Plot A. Dried blood 4 cwt. per acre, basic slag 4 cwt. per acre, sulphate of potash 1½ cwt. per acre.		Plot B. No manure.		Plot C. Mulched with grass, 5 tons per acre.		Plot D. Dried blood 4 cwt. per acre.		Pot E. Sulphate of ammonia 2½ cwt. per acre.		Plot F. Sulphate of potash 1½ cwt. per acre		Plot G. Basic slag 4 cwt. per acre.		Plot H. Dried blood 4 cwt. per acre, basic slag 4 cwt. per acre.	
	Standard barrels,	Standard barrels,	Standard barrels,	Standard barrels,	Standard barrels,	Standard barrels,	Standard barrels,	Standard barrels,	Standard barrels,	Standard barrels,	Standard barrels,	Standard barrels,	Standard barrels,	Standard barrels,	Standard barrels,	Standard barrels.
1914 ...	6	24	5½	23	3½	14	4½	17	8	32	1½	6	4	16	7	28
1915 ...	23½	94	13½	53	10	40	17½	71	10½	65	7	28	9½	37	22½	89
1916 ...	43	172	15½	62	24	96	24½	98	24½	99	10	40	19	76	31½	126

DISCUSSION OF RESULTS.

A study of these figures indicates the progress made by the trees in the various plots since the experiment was laid out three years ago. The yield during the first year was very low on all the plots; there was a substantial increase in the second year, and a further increase during the year under review.

The uneven nature of the plots, for the reasons given in the opening paragraphs of this report, and the short time during which these experiments have been running, make it inadvisable to draw definite deductions as to the manurial requirements of lime trees. It will be necessary to carry on the experiments for a considerable number of years, and probably to extend them in certain directions to obtain reliable data.

Three or four facts are, however, so outstanding when the results of these experiments are examined, both with regard to their crop returns and the general appearance of the trees, that even at this stage it is justifiable to bring them to the notice of those interested.

1. Without the application of manures the yield of lime trees is small, and the trees themselves present the appearance of having scanty foliage, lacking in colour, and the growth of new wood is sparse.

2. In these experiments the application of a complete manure containing nitrogen, phosphoric acid, and potash increases the yield per acre to such an extent that with limes selling at 3s. 6d. per barrel, and the manure costing £5 per acre, an increase of 110 barrels was obtained over the no-manure plot, which at the same valuation yielded a profit of £12 per acre. Furthermore, the appearance of the trees on the complete manure plot is all that can be desired.

3. The application of a manure containing nitrogen and phosphoric acid, but having no potash, whilst increasing the yield of fruits to a marked degree over the no-manure plot, leaves something to be desired when compared with the complete manure plot. In normal times the additional cost of supplying potash is amply repaid by the increased yield obtained.

4. The application of a mulch consisting of 5 tons of grass per acre per annum is producing a steady improvement in the yield of the trees, and in their general appearance.

It is realized by the officers responsible for these experiments that in many ways they are not altogether satisfactory. The acreage available is much too small to carry out a really efficient series of experiments. All that is claimed for them is that they are reliable indications as to the benefit to be derived by adopting a reasonable system of manuring.

No attempt is made, for instance, to demonstrate that one form of phosphatic manure is superior to another, or that one form of potash is preferable to another. Such fine points would require a large number of duplicate plots to yield reliable results. There are other important data which could be made available if we had a sufficient acreage at our disposal. In these experiments the formula selected for the manures is one containing 54lb. nitrogen, 72lb. phosphoric acid, and 84lb. potash per acre, and this amount is added annually to the complete manure plot. This formula was selected because it was considered that its cost, which is about £5 per acre, is as much as is likely to be expended on manures in Dominica. It is highly probable that by increasing the quantities of the manures higher yields may be obtained. It may here be mentioned that in Porto Rico on orange groves no less than 62lb. nitrogen, 131lb. phosphoric acid and 200lb. potash per acre are frequently supplied with profitable results.

Again, in this experiment the manure is applied once a year, usually in the month of May or June. Many planters maintain that the correct season for applying manures is in November or December. The only way to settle this question is to lay out experiments. In the meantime it may be suggested for the benefit of those who make liberal applications, that the best course to follow is probably to apply one half in June and the other half in November.

ADDITIONAL EXPERIMENTS WITH LIMES.

The experiments conducted in Dominica afford therefore merely general indications, and, though in many ways imperfect, it is hoped that planters by adopting the basic principles which in course of time will be brought to light through these experiments, will be able to increase their yield per acre and keep their trees in a vigorous state of health.

SERIES 2. WITH YOUNG LIMES.

This series consists of eight $\frac{1}{4}$ -acre plots of young trees; it is intended to duplicate with these the experiments carried on with the old trees. They were planted in July 1913, in holes 20 feet apart each way. For the first two years the trees were sprayed regularly, which together with an occasional weeding was all the treatment they received, and they made excellent progress. At the beginning of 1915 it was decided to give up the spraying, hoping that the trees were sufficiently established to withstand any possible attacks of scale insects, and that with the aid of their natural enemies these would be kept in check. It was soon evident, however, that the scale insects were making great headway, and the year closed with the most of the trees seriously injured by attacks of scales, and in many cases the whole of the tops were killed almost to the root. During the latter half of the year each tree was given an application of an organic manure, which is to be repeated in May of this year. It is hoped that this treatment will in time restore the trees to good health. If this does not succeed, it may be necessary to start spraying operations again.

It is unfortunate that the plots should have received this serious set-back; it will take several years before they will present an even appearance again; on the other hand, it will afford a good opportunity of observing and recording the results of the treatment followed in outbreaks of this nature which, after all, is almost the natural course of events on estates established on old cane or garden land near the coast, though almost unknown on estates cleared from forest.

ADDITIONAL EXPERIMENTS WITH LIME CULTIVATION.

Two additional manurial plots of old lime trees, approximately $\frac{1}{4}$ -acre each, were laid out a year after the main series. These are situated in a rather exposed position; the soil is heavy and in very bad tilth, consequently the trees lack vigour and produce but a small crop. It will be interesting to observe the effect of manures under such conditions. The following table indicates the manure applied, the rate per acre, and the yield of fruit in barrels per plot and per acre, during the two years the experiment has been running:—

Year ending March 31.	Plot I. Cotton-seed meal 10 cwt. per acre, and lime at the rate of 5 cwt. per acre.		Plot K. Mulched with grass $2\frac{1}{2}$ tons per acre, and lime at the rate of 5 cwt. per acre.	
	Yield in barrels.		Yield in barrels.	
	Per plot.	Per acre.	Per plot.	Per acre.
1915	1	4	2	8
1916	2	8	6	24

It will be observed that the crop was practically nil when the experiment was first started.

Within the area enclosed by a fence early in 1914 there was sufficient land to lay out six additional $\frac{1}{4}$ -acre plots. Three of these were planted in seedling limes in July 1914. By repeated sprayings they have been kept free from injury due to scale insect attacks, and have made satisfactory progress. One of the plots has been kept clean weeded throughout the year; a second grew a crop of horse beans (*Canavalia ensiformis*), and a third has a growth of *Tephrosia candida* still growing between the limes. The remaining three $\frac{1}{4}$ -acre plots were planted in July 1915

CACAO MANURIAL EXPERIMENTS.

with limes budded on sour orange stocks: two plots with the ordinary limes, and the third with spineless limes. These trees have also been kept free from serious scale insect attacks by spraying, and they have made satisfactory progress. The spineless lime plot has been interplanted with Rounceval peas (*Vigna unguiculata*) as a green dressing. One of the remaining is planted with (*Tephrosia candida*) and the other is allowed to grow in grass and occasionally cutclashed or hoed. These three plots are of the greatest interest and importance.

During the year 1915-16, in order to round off the experiment station, a further area of about $1\frac{1}{2}$ acres of steep land was planted with lime trees.

EXPERIMENTS WITH DYNAMITE.

Reference to previous progress reports will show that the Department during the year 1914 conducted several experiments to demonstrate the effect of dynamite explosions in lime cultivation.

Two main experiments were conducted: (1) by a series of explosions among established lime trees, and (2) by the use of dynamite in the making of holes for planting. In this latter experiment alternate rows of holes were dynamited, the remaining rows being soon after made with the spade in the ordinary way.

After a period of two years has elapsed no advantage is to be observed in the treated trees in the first experiment, and the dynamited rows show no advantage whatsoever over the ordinary spade-made holes.

II.—MANURIAL EXPERIMENTS WITH CACAO.

The customary review of the results attained in the manurial experiments with cacao conducted by the Agricultural Department in Dominica is given in the following pages.

The practice has been followed in former reports of dividing the experiments into series, and of discussing the results of each separately. The length of time during which three of these series of experiments have now been conducted is such that reliable information is available, and there is no further need to keep them separate. In this year's report they are regarded as one. The fourth series comprise plots started in 1913-14, and as the experiments are of recent date, no attempt is made to draw definite conclusions therefrom. It is hoped that the system adopted of presenting the results on this occasion will simplify matters and make it easier for those interested to follow the results obtained.

The first seven plots are situated on level ground and occupy approximately 2 acres. The soil is moderately even in character, especially that of plots 1, 2, 3, 6 and 7. Plots 4 and 5 being on a lower level are rather heavier; plot 4 being distinctly so.

Plots 8 and 9 are situated on a steep hillside, a situation typical of many acres of cultivation in Dominica.

The first five plots were started in the year 1902-3, and similar treatment has been accorded to each plot in every succeeding year, so that at the present time the condition of each represents the accumulated results of fourteen years' continuous treatment on the same lines. The remaining four plots were started five years later, and each individual plot has thus obtained identical treatment for nine years.

CACAO MANURIAL EXPERIMENTS.

The following table shows the number of trees per plot and per acre at the present time, the area of each plot, the manurial treatment received, and the year of the first application of the manure :—

No.	Letter on station plan.	No. of trees per plot, 1916		Area of plots in acres.	Manurial treatment.	Year of first application.
		Bear-ing.	Non-bear-ing.			
1	C	54	15	0.28	No manure.	1902 3
2	A	60	6	0.29	Basic slag 4 cwt. per acre. Sulphate of potash $1\frac{1}{2}$ " " "	"
3	B	66	5	0.36	Dried blood 4 " " "	"
4	E	42	6	0.29	Basic slag 4 " " " Dried blood 4 " " " Sulphate of potash $1\frac{1}{2}$ " " "	"
5	D	49	4	0.37	Mulched with grass and leaves 5 tons per acre.	"
6	F	49	6	0.25	Mulched with grass and leaves 4 tons per acre.	1907
7	G	50	3	0.25	Cotton-seed meal 600 lb. per acre.	"
8	H	86	2	0.414	No manure.	"
9	I	88	1	0.373	Mulched with grass and leaves 5 tons per acre.	"
10	K	106	...	0.4	Mulched with grass and leaves $2\frac{1}{2}$ tons per acre. Lime 5 cwt. " "	1913
11	L	95	...	0.25	Calcium cyanamide (Nitrolim) $2\frac{1}{2}$ cwt. per acre.	"

Some years ago the plan was adopted of planting on each plot a sufficient number of trees to cover the ground, and the figure given represents the number of bearing trees in each plot at the present time. In several plots a number of trees have recently died, especially in the control plot 1, there being no fewer than fifteen non-bearing trees in this plot at the present time. The continued fluctuation in the number of trees render the figure for the yield per tree very uncertain, and this has in consequence been omitted from the results for the season now under review.

The plots have received the same manurial dressings as in previous years. The method of application consists of raking the leafage in a circle round each tree, to apply the manure in the space thus uncovered, and then to rake back the leaves over the manure. In those plots receiving both basic phosphate and dried blood, an interval of several weeks is allowed between the application of the two manures. The mulch after being carefully weighed is scattered evenly over the surface of the plot. The material of which the mulch is composed is of two types, varying widely in their chemical composition. To the mulched plots 5 and 6, varying quantities of mulch composed largely of fallen leaves and pods of the Saman tree (*Pithecolobium Saman*) are used; for plots 9 and 10 no Saman tree material is utilized, but in this case the fallen leaves of the West Indian mahogany tree (*Swietenia Mahagoni*) supply the mulching material. The manures and the mulch are applied once a year. These are the sources of coarse organic matter

CACAO MANURIAL EXPERIMENTS.

which are available in an experiment station of this nature. Similar results would in all probability be obtained by the use of many other forms of organic matter. As an appendix to this report is given the analysis of a large number of materials which could be utilized equally well. Several of these are under experiment in this station, and reliable information as to the quantity which can be produced, and the cost of production will we hope be soon available. The value of several of these manures such as pen manure, sheep manure, etc., are well known and appreciated by planters.

No forking has been performed in any of the plots since the inception of the experiments; the only cultural operations undertaken beyond the application of the manures being the usual ones connected with the pruning of trees and sanitation of the orchard.

The yields of cacao recorded each year are for periods of twelve months terminating on June 30. This date is chosen because there is no cacao being gathered at that time. Other dates possess the disadvantages that, owing to the fluctuations in the spring or carême crop, it may happen that two such crops are included in one year: a late crop of one year and an early crop of the succeeding year; while on other occasions there may be no carême crop in the year under review. Such fluctuations disturb and confuse the records, hence the results are made to refer to the crop year extending from July 1 to June 30. This mode of reckoning is recommended for adoption as a basis of records in connexion with West Indian cacao crops.

The annual rainfall for each year since the inception of the experiments is given below. In accordance with the matter in the previous paragraph, the figures are given for twelve months commencing on July 1 of one year and ending on June 30 of the next.

Period.					Year.	Inches.
Twelve months ending June 30.						
"	"	"	"	"	1903	72.46
"	"	"	"	"	1904	93.02
"	"	"	"	"	1905	70.13
"	"	"	"	"	1906	74.60
"	"	"	"	"	1907	69.02
"	"	"	"	"	1908	67.08
"	"	"	"	"	1909	69.47
"	"	"	"	"	1910	94.90
"	"	"	"	"	1911	89.71
"	"	"	"	"	1912	80.54
"	"	"	"	"	1913	64.76
"	"	"	"	"	1914	71.60
"	"	"	"	"	1915	80.00
"	"	"	"	"	1916	94.10

The following table shows the yields in the year under review, together with those from the plots in each year since the systematic record of the returns was first undertaken.

The yields of the past year are shown in the bottom line of the table. This method enables the progress of each of the plots to be seen at a glance. The yields are given in terms of wet cacao per plot, and pounds per acre, and cured cacao pounds per acre. In calculating the yield of cured cacao per acre, the assumption is made that 100 lb. of wet cacao will yield 42 lb. of cured cacao.

CACAO MANURIAL EXPERIMENTS.

Year.	Plot 1.		Plot 2.		Plot 3.		Plot 4.		Plot 5.	
	No manure.		Phosphate and potash.		Dried blood.		Dried blood, phosphate and potash.		Mulched with grass and leaves.	
	Per plot.	Per acre.	Per plot.	Per acre.	Per plot.	Per acre.	Per plot.	Per acre.	Per plot.	Per acre.
1902-3.										
Wet cacao ...	759	2,711	1,063	3,666	1,281	3,588	1,104	3,807	1,145	3,095
Cured cacao ...	...	1,138	...	1,540	...	1,494	...	1,599	...	1,300
1903-4.										
Wet cacao ...	548	1,956	808	2,786	970	2,694	738	2,545	962	2,600
Cured cacao ...	...	822	...	1,170	...	1,131	...	1,069	...	1,092
1904-5.										
Wet cacao ...	673	2,403	814	2,801	970	2,694	979	3,376	1,279	3,457
Cured cacao ...	...	1,009	...	1,179	...	1,131	...	1,418	...	1,450
1905-6.										
Wet cacao ...	748	2,672	763	2,631	1,056	2,933	1,040	3,586	1,519	4,105
Cured cacao ...	...	1,122	...	1,105	...	1,232	...	1,506	...	1,724
1906-7.										
Wet cacao ...	730	2,607	887	3,059	972	2,700	1,009	3,479	1,536	4,151
Cured cacao ...	...	1,095	...	1,285	...	1,134	...	1,461	...	1,743
1907-8.										
Wet cacao ...	903	3,225	1,160	4,000	1,381	3,836	1,180	4,069	1,773	4,792
Cured cacao ...	...	1,354	...	1,680	...	1,611	...	1,709	...	2,012
1908-9.										
Wet cacao ...	978	3,492	1,205	4,155	1,377	3,825	1,344	4,634	1,777	4,803
Cured cacao ...	...	1,467	...	1,745	...	1,607	...	1,946	...	2,017
1909-10.										
Wet cacao ...	848	3,029	963	3,321	1,167	3,241	1,267	4,369	1,822	4,924
Cured cacao ...	...	1,272	...	1,395	...	1,361	...	1,835	...	2,068
1910-11.										
Wet cacao ...	859	3,067	1,097	3,783	1,289	3,581	1,297	4,473	1,890	5,107
Cured cacao ...	...	1,288	...	1,589	...	1,504	...	1,879	...	2,145
1911-12.										
Wet cacao ...	804	2,871	1,012	3,490	1,272	3,583	1,272	4,387	1,721	4,651
Cured cacao ...	...	1,206	...	1,466	...	1,484	...	1,842	...	1,953
1912-13.										
Wet cacao ...	892	3,186	1,088	3,752	1,512	4,200	1,314	4,531	2,001	5,408
Cured cacao ...	...	1,338	...	1,576	...	1,764	...	1,903	...	2,271
1913-14.										
Wet cacao ...	678	2,422	885	3,050	1,133	3,147	1,101	3,807	1,509	4,078
Cured cacao ...	...	1,017	...	1,281	...	1,322	...	1,599	...	1,713
1914-15.										
Wet cacao ...	779	2,782	1,049	3,617	1,366	3,794	1,133	3,907	1,715	4,635
Cured cacao ...	...	1,168	...	1,519	...	1,593	...	1,641	...	1,947
1915-16.										
Wet cacao ...	715	2,554	1,110	3,827	1,298	3,607	1,069	3,686	1,474	3,984
Cured cacao ...	...	1,073	...	1,607	...	1,514	...	1,548	...	1,673

CACAO MANURIAL EXPERIMENTS.

Year.	Plot 6.		Plot 7.		Plot 8.		Plot 9.		Plot 10.		Plot 11.	
	Mulched with grass and leaves.		Cotton-seed meal.		No manure.		Mulched with grass and leaves.		Mulched with grass and leaves.		Calcium cyanamide (nitrolim).	
	Per plot.	Per acre.	Per plot.	Per acre.	Per plot.	Per acre.	Per plot.	Per acre.	Per plot.	Per acre.	Per plot.	Per acre.
1907-8.												
Wet cacao ...	881	3,524	1,019	4,076	882	2,130	1,053	2,823				
Cured cacao ...	...	1,480	...	1,712	...	895	...	1,186				
1908-9.												
Wet cacao ...	1,119	4,47	1,060	4,240	957	2,311	1,214	3,255				
Cured cacao ...	...	1,880	...	1,781	...	971	...	1,367				
1909-10.												
Wet cacao ...	1,242	4,969	1,039	4,156	965	2,331	1,352	3,625				
Cured cacao ...	...	2,087	...	1,746	...	979	...	1,523				
1910-11.												
Wet cacao ...	1,225	4,900	1,006	4,024	977	2,360	1,897	5,086				
Cured cacao ...	...	2,058	...	1,690	...	991	...	2,136				
1911-12.												
Wet cacao ...	1,070	4,280	923	3,692	924	2,232	1,669	4,476				
Cured cacao ...	...	1,798	...	1,549	...	937	...	1,879				
1912-13.												
Wet cacao ...	1,377	5,508	1,207	4,828	845	2,041	1,674	4,487				
Cured cacao ...	...	2,313	...	2,028	...	857	...	1,885				
1913-14.												
Wet cacao ...	1,300	5,200	924	3,696	767	1,853	1,548	4,150	667	1,667	609	2,436
Cured cacao ...	...	2,184	...	1,552	...	778	...	1,743	...	700	...	1,023
1914-15.												
Wet cacao ...	1,529	6,116	1,229	4,916	947	2,287	1,750	4,692	899	2,242	782	3,128
Cured cacao ...	...	2,569	...	2,065	...	960	...	1,971	...	942	...	1,314
1915-16.												
Wet cacao ...	1,380	5,520	977	3,908	814	1,966	1,432	3,839	1,024	2,560	795	3,180
Cured cacao ...	...	2,318	...	1,641	...	825	...	1,612	...	1,075	...	1,336

CACAO MANURIAL EXPERIMENTS.

The following supplementary table gives the average annual return of wet and dried cacao in pounds for fourteen years in the case of the first five plots, and for nine years in the case of plots 6 to 9. The last column shows the percentage increase of each plot over the no-manure plot :—

No.	Manurial treatment.	Wet cacao,		Cured cacao per acre.	Increased over no-manure plot, per cent.
		per plot.	per acre.		
1	No manure	779	2,782	1,168	...
2	Phosphate and potash ...	993	3,424	1,437	23·0
3	Dried blood	1,217	3,380	1,419	25·5
4	Dried blood, phosphate and potash	1,132	3,905	1,640	40·4
5	Mulched with grass and leaves	1,586	4,271	1,794	53·6
6	" " " " "	1,235	4,940	2,075	77·6
7	Cotton-seed meal	1,013	4,772	1,752	50·0
8	No manure	898	2,169	911	...
9	Mulched with grass and leaves	1,510	4,049	1,700	86·6

The pecuniary aspect of the experiment is dealt with in the two following tables in which are shown the gain from the application of the different manures both for the average return of the entire period during which the experiments have been conducted, and for the year under review. In calculating the monetary gain, the value of cured cacao has, as in previous reports, been assumed at 6*d.* per *lb.* During the last two years the value of cacao has been very considerably higher than this; at the same time the cost of the manures has risen, especially sulphate of potash, which is practically unobtainable on a commercial scale.

Under these circumstances, it is thought best not to change the values, at least not until conditions are more settled.

In calculating the monetary gain resulting from the application of the various manures, the cost of collecting and applying the mulch to the various mulched plots has been assumed at 80*s.* per acre. In practice at the Botanic Gardens, it is considerably less than this since the collecting of the fallen leaves constitutes a part of the ordinary routine in the care of the grounds. It is estimated, however, that a mulch of the size indicated could be obtained from the surrounding bush and applied under the conditions obtaining on a cacao estate in Dominica for the sum mentioned. Further, under estate conditions in Dominica, sheep and pen manure can be made at a cost of under 20*s.* per ton, and this when applied to the cultivation would produce similar results to the mulch referred to above.

CACOA MANURIAL EXPERIMENTS.

The following table shows the average monetary gain from manuring over the whole period of the experiments :—

Plot.	Average annual yield of cured cacao, per acre.	Gain in cured cacao over no manure.	Value per acre of increase over no manure at 6d. per lb. of cured cacao.	Cost of manuring per acre.	Gain per acre by manuring.
	lb.	lb.	s. d.	s. d.	s. d.
1	1,168	...	...	...	...
2	1,437	251	134 6	45 3	89 3
3	1,419	269	125 6	52 0	73 6
4	1,640	472	236 0	97 3	138 9
5	1,794	626	313 0	80 0	233 0
6	2,075	907	453 6	80 0	363 6
7	1,752	584	292 0	40 0	252 0
8	1,900	...	...	...	...
9	1,700	789	394 6	80 0	314 6

The monetary gain for manuring during the year 1915-16 may be shown as follows :—

No.	Yield per acre of cured cacao, 1915-16.	Gain per acre over no manure.	Value per acre of increase over no manure at 6d. per lb. of cured cacao.	Cost of manure per acre.	Gain per acre by manuring.
	lb.	lb.	s. d.	s. d.	s. d.
1	1,073	...	...	...	...
2	1,607	534	267 0	45 3	221 9
3	1,514	441	220 6	52 0	168 6
4	1,548	440	220 0	97 3	122 9
5	1,673	600	300 0	80 0	220 0
6	2,318	1,245	622 6	80 0	542 6
7	1,641	568	284 0	40 0	244 0
8	825	...	...	...	...
9	1,612	539	269 6	80 0	189 6

Early in the history of these experiments the plots suffered a severe check as a result of a storm that passed over the island in 1903. After some two years the plots recovered and there was no further disturbing factor of any consequence for twelve years. During the year under review, however, in August there passed over the island a severe storm accompanied by heavy downpours of rain, with a repetition of the same weather conditions in September. Most of the plots suffered more or less severely; but plots 4 and 5 being the most exposed and lying on land of lower level than the other plots suffered most, and this accounts for the decreased yields recorded from these two plots during the year under review.

Apart from the two storms referred to, the rainfall during the whole period was exceptionally heavy, and the year cannot be regarded as a favourable one for cacao. The control plots Nos. 1 and 8 both showed a decrease over the previous year, and yielded slightly less than the average yield over the whole period. The mean yields of the two plots for the year under review was a pound short of 1,000 lb. of cured cacao per acre. There were again a number of deaths in the original control plot; the dead trees were dug out and young ones supplied. The difficulty with which the no-manure plots are kept owing to the prevalence of disease on these plots is in itself a striking testimony to the increased vigour of trees suitably nourished. There are far more young non-bearing trees on the control plot than on any of the other plots.

Plot 2, which receives sulphate of potash and basic slag yielded during the year at the rate of 1,607 lb. of cured cacao per acre—the highest yield recorded from this plot for a number of years. The trees themselves, however, lacked the vigour of those receiving nitrogen, and resemble closely in appearance those on the control plots.

The plot receiving dried blood, but no phosphate and potash yielded 100 lb. more cured cacao than the average over fourteen years, but 5 per cent. less than the previous year's crop. The trees on this plot are healthy and vigorous.

Plot 4 receiving a complete manure of nitrogen, phosphate and potash, as has already been pointed out, suffered severely as the result of repeated washing of the soil owing to the heavy rains, and the year's output from this plot dropped 8 per cent. below the previous year's crop, and 7 per cent. less than the average yield over fourteen years. The trees appear to have suffered even more than is indicated by the crop disease, and it is feared that a further drop will be recorded during the next year or two.

Cotton-seed meal, which was cheaply obtainable in these islands when cotton was grown extensively, has proved over a number of years to be a manure well suited to the requirements of orchard cultivation. It has been applied annually for nine years to plot 7, and the average yield over this period amounted to 1,752 lb. of cured cacao per acre, or 584 lb. more than the yield obtained from the no-manure plot. The quantity of nitrogen applied to this plot with an application of 600 lb. per acre is small, probably not more than 24 lb. per acre, and in a general way the trees appear to be lacking in this constituent, and have the same appearance as the trees growing in plots 1 and 2, which receive no nitrogen.

Satisfactory as the results obtained with the use of concentrated foreign manures are, the main feature brought out by these experiments is the great superiority of the mulching method of manuring over all others. Plots 5, 6, and 9 are treated in this way, and the mean results from these three plots show what it is possible to do by this system of manuring. The mean yield from these three plots for the year under review was 1,868 lb. of cured cacao per acre or 795 lb. more cacao than was obtained from the no-manure plot. The average yield from these three plots for a long series of years is 1,856 lb. of cured cacao per acre or 688 lb. cured cacao more than the no-manure plot, equal to a percentage increase of 58.8.

It is now universally acknowledged that the application of coarse organic matter to the soil is the most satisfactory method of improving the soil and of producing large crops, especially under tropical conditions. This has been demonstrated with annual crops such as sugar-cane, and these experiments confirm

COMPOSITION OF ORGANIC MANURES.

in an unmistakable manner that the same principle holds good in orchard cultivation. Not only does the application of organic matter improve the texture of the soil, but it is essential to the biological life of the soil and the subsequent production of plant food material.

The care with which organic matter is conserved and pen manure is made in many of the colonies producing sugar-cane is quite sufficient to show that its value is appreciated by experienced agriculturists, but when it comes to orchard cultivation many argue that it is too expensive a method of manuring.

It is customary to apply, and it has been shown by experiment that profitable results follow an application of 20 tons of pen manure per acre to plant canes, and as canes are often only allowed to ratoon two or three times, this application is equivalent to an annual application of manure of 5 tons per acre per annum. If an application of a similar amount is made to orchard soils annually, then the conditions represented on the mulched plots of these experiments are reproduced.

If orchard cultivators were prepared to manure as liberally as sugar-cane growers by an annual expenditure of about 80s. per acre on the production of good pen, sheep or stable manure, made in well constructed pens, or by the application of bush and grass, excellent yields would be obtained and the capital value of their orchards would be considerably enhanced.

APPENDIX.

KEY TO TABLE ON FOLLOWING PAGE SHOWING COMPOSITION OF PEN MANURE
AND ALLIED MANURES.

Analysis of manures made at the Government Laboratory, Antigua.

1. Pen manure, Antigua
2. " "
3. " "
4. " "
5. " "
6. " "
7. " "
8. " "
9. " "
10. " "
11. " "
12. Purchased stable manure, Antigua
13. " manure, St. Kitts
14. Sheep pen manure, Antigua
15. " "
16. " " Barbados
17. Bat guano, Barbuda (leached by exposure to air and water
and subsequently sun-dried)
18. Bat guano, Antigua
19. Stable manure (sample 1), Antigua. Somewhat leached by
exposure to air
20. Stable manure (sample 2) Antigua. Somewhat leached by
exposure to air
21. Rotted megass and compost from lees pond, Antigua
22. " " Antigua
23. Vegetable compost, Antigua
24. Mahogany leaves and pods, Dominica
25. Pods of *Pithecolobium Saman*, Antigua
26. Weeds, leaves, etc., Botanic Station, Dominica (consisting
mainly of *Saman* leaves and pods)
27. Leaves of dagger (*Agave*), Antigua
28. Bush, etc., Antigua
29. Cane tops
30. " "
31. " "
32. " trash
33. Lemon grass (fresh), Antigua
34. " " (air-dried) Dominica
35. " " Antigua. Exhausted by steam in the distilla-
tion of lemon grass oil, and air-dried
36. Hay grass, Antigua. Air-dried
37. Mixed grass cut from hillside at Botanic Station, Dominica,
and air-dried
38. Grass used for mulch at Picard, Dominica. Air-dried
39. Clippings from *Gliricidia maculata*, Dominica. Air dried
40. Crushed cotton seed, Antigua
41. Cotton cake meal, Barbados
42. Maize cobs, Antigua. Air-dried
43. Cacao husks, Dominica
44. Seaweed, Antigua
45. Lime skins and pulp, Antigua
46. Lime seeds from Dominica Air-dried
47. Pigeon pea stems and leaves (air-dried), Antigua
48. Cane tops (air-dried) St. Kitts
49. " " " "
50. Coco-nut husk. " Nevis "
51. Sea Island cotton-seed meal, St. Kitts
52. French weed (*Commelyna nudiflora*)
53. Sweet potato vine

COMPOSITION OF PEN MANURE AND ALLIED MANURES.

NO.								POUNDS PER TON.						
	Water.	Organic matter.	Ash.	Phosphoric acid (P_2O_5).	Potash (K_2O).	Nitrogen.	Ammonia (NH_3).	Water.	Organic matter.	Ash.	Phosphoric acid (P_2O_5).	Potash (K_2O).	Nitrogen.	Ammonia (NH_3).
1	56.54	19.35	24.11	...	...	.53	.65	1,267.0	433.4	539.6	...	...	11.90	14.40
2	31.07	57.77	11.16	.30	.38	.58	.70	696.0	1,294.0	250.0	6.60	8.50	13.00	15.80
3	27.64	39.39	32.97	.33	1.54	.88	1.07	619.0	882.3	738.5	7.10	34.50	19.70	24.00
4	59.82	19.98	20.20	.15	.12	.42	.51	1,340.0	447.6	452.5	3.30	2.60	9.30	11.30
5	60.52	...	...	.27	.87	.92	1.11	1,356.0	...	...	6.00	19.50	20.50	24.90
6	49.27	28.17	22.56	.01	.83	1.07	1.30	1,104.0	631.0	505.4	.10	18.60	23.90	29.00
7	71.80	9.76	19.44	.22	.81	.68	.83	1,598.0	423.4	218.6	4.93	11.42	15.23	18.40
8	69.68	18.86	11.46	.17	.52	.53	.64	1,561.0	422.4	256.6	3.81	7.17	11.87	14.40
9	33.40	51.00	15.60	.36	.74	1.05	1.52	748.2	1,142.4	349.4	8.06	16.62	28.00	34.00
10	40.18	20.52	39.30	.14	.21	.40	.49	900.4	459.7	879.9	3.14	4.70	8.96	10.80
11	16.56	25.00	28.44	.15	.52	.54	.66	1,043.0	573.5	637.6	3.36	11.65	12.10	14.60
12	57.80	17.88	24.32	.18	.72	.62	.75	1,295.0	400.5	544.5	4.03	16.13	13.89	16.80
13	11.15	...	...	.58	1.31	.80	.97	249.8	...	...	12.99	29.34	17.92	21.70
14	21.68	...	...	.57	2.55	...	...	485.6	...	...	12.80	57.10	...	...
15	40.60	32.14	27.26	.42	.79	1.28	1.55	909.5	720.0	620.5	9.41	17.70	28.67	34.80
16	38.37	32.85	28.78	.48	1.30	1.29	1.57	859.5	735.8	644.7	10.75	29.12	28.90	35.10
17	2.75	15.31	81.94	22.26	6.09	.29	.35	61.6	342.7	1,835.5	498.6	136.4	6.50	7.80
18	33.12	...	...	1.04	1.31	1.04	1.26	741.9	...	...	23.36	29.25	23.18	28.10
19	36.96	41.35	21.69	.69	1.04	.38	.46	827.9	926.2	486.0	15.46	23.30	8.51	10.30
20	37.02	46.34	16.64	.64	.92	.31	.37	829.2	1,038.0	372.8	14.34	20.61	6.94	8.20
21	67.60	10.60	21.80	.07	.13	.29	.35	1,498.3	237.4	488.3	1.54	2.81	6.49	7.80
22	67.04	16.76	16.20	.19	.13	.04	.45	1,500.8	375.4	359.7	4.23	2.98	.83	1.00
23	45.60	46.30	48.10	.01	.51	.41	.49	1,002.8	1,159.3	1,077.4	.89	11.33	8.96	10.80
24	14.88	...	...	...	...	.78	.95	333.3	...	...	...	...	17.47	21.20
25	16.80	...	...	...	...	2.60	3.16	376.3	...	...	...	...	58.24	70.70
26	12.62	77.90	9.48	.16	.64	2.12	2.57	282.6	1,745.0	212.40	3.49	14.42	47.40	57.60
27	87.07	11.35	1.58	.02	.26	.11	.13	1,950.4	263.1	36.50	.43	5.82	2.46	2.90
28	56.98	39.13	3.89	.12	.72	.69	.83	1,276.3	876.5	87.20	2.61	16.19	15.34	18.60
29	23.83	69.97	6.22	...	...	.61	.74	533.8	1,566.9	139.30	...	...	13.70	16.60
30	17.60	74.66	7.81	...	...	.62	.75	391.2	1,670.2	175.60	...	...	13.90	16.80
31	68.41	29.36	2.23	...	...	.22	.26	1,532.0	658.0	50.0	...	...	4.90	5.80
32	12.51	82.32	5.21	.05	.34	.32	.38	280.0	1,844.0	116.60	1.10	7.60	7.30	8.90
33	70.16	26.29	3.55	.06	.39	.34	.44	1,571.6	588.9	79.52	1.34	8.74	7.62	9.80
34	13.03	...	...	.37	1.16	.51	.62	291.9	...	...	8.29	25.98	11.42	13.80
35	21.61	69.90	8.49	.22	.55	1.19	1.44	484.1	1,565.8	190.18	4.93	12.32	26.66	32.20
36	13.42	...	...	.04	.97	.66	.80	300.6	...	...	8.96	21.73	14.78	17.90
37	9.97	...	...	.22	.80	.83	1.01	224.3	...	...	4.93	17.92	18.59	22.60
38	10.83	...	...	.22	.99	.74	.89	242.6	...	...	4.93	22.18	16.78	19.90
39	11.69	...	...	.40	...	3.12	3.79	261.9	...	...	8.96	...	69.89	84.90
40	11.17	88.57	4.26	.93	.98	2.86	3.47	250.2	1,894.4	95.40	20.83	21.95	61.07	77.70
41	10.80	84.00	5.20	1.20	1.07	4.59	5.57	241.9	1,881.6	106.50	26.88	24.0	100.34	121.80
42	9.50	88.74	1.76	.20	.27	.39	.47	212.8	1,986.9	39.40	4.48	6.05	8.74	10.50
43	11.7	...	...	.32	1.95	1.19	1.44	262.1	...	...	7.17	43.68	26.66	32.20
44	69.0	8.84	22.16	.10	.58	.36	.44	1,545.6	198.0	496.40	2.24	12.99	8.06	9.70
45	75.36	23.63	1.01	.01	.15	.31	.38	1,678.9	438.5	22.60	.13	3.31	7.03	8.50
46	9.30	88.2	2.49	.58	.35	1.11	1.35	208.3	1,975.7	55.78	12.99	7.91	24.86	30.20
47	10.78	82.22	7.00	.56	1.01	2.00	2.43	242.0	1,841.0	157.0	12.5	22.6	44.8	54.40
48	11.81	80.59	7.60	.31	1.84	.72	.87	264.3	1,806.0	170.3	6.94	41.2	16.12	19.50
49	11.11	80.42	8.47	...	...	.77	.94	248.6	1,801.0	183.8	...	...	17.2	21.10
50	13.77	83.00	3.23	.05	.95	.24	.29	309.1	1,859.0	72.3	1.12	2.13	5.4	6.50
51	10.51	84.56	4.93	1.65	1.12	4.14	5.03	235.4	1,895.0	110.5	3.70	25.1	92.7	112.70
52	80.64	8.24	2.12	...	...	.33	.40	2,008.0	184.6	47.5	...	...	7.4	9.00
53	87.84	10.66	1.50	...	...	.34	.41	1,968.0	238.8	33.6	...	...	7.6	9.20

SAMPLES ANALYSED.

Work in Chemical Laboratory.

By the beginning of the year 1915-16, arrangements had been completed for the reorganization of the chemical work carried on in the Leeward Islands Colony. Prior to this date the work had been undertaken in the Government Laboratory, Antigua, each Colony contributing its quatum towards the maintenance of that institution.

During the year under review, branch laboratories were established in Dominica and St. Kitts.

The post of Assistant Chemist in Antigua was abolished and appointments made in the islands mentioned. Mr. G. A. Jones, the Assistant Curator, was appointed Chemist in Dominica in addition to carrying on his duties as Assistant Curator.

For the present, therefore, and until other arrangements can be made, the time of this officer is divided up between the work of the two appointments.

The office used by the Assistant Curator was temporarily converted into a chemical laboratory. During 1916 it is hoped that the present office buildings will be enlarged to provide adequate laboratory accommodation.

Owing to the present conditions there has been a considerable delay in obtaining chemical supplies from England. Fortunately, however, during the last two or three years the Imperial Commissioner of Agriculture had allowed small expenditures from the Imperial Grant-in-aid towards the gradual accumulation of the necessary chemical appliances. Consequently when the reorganization was finally approved, there was a sufficient supply on hand to enable some work to proceed without having to wait for the arrival of the apparatus ordered from England.

The following is a summary of the samples analysed during the year :—

SAMPLES ANALYSED.

Lime juice samples (estates)	...	...	...	45
Manures	...	...	...	7
Lime (for citrate making)	...	...	...	1
Citrate of lime	...	...	...	4
Coral rock (suspected)	...	...	...	1
Making standard solutions	...	...	...	6
Lime juice samples (for purposes of investigation)	...	...	...	88
Citric acid determination (Warrington) on lime juice	...	...	...	49
Milk	...	...	...	13
Total	...	...	...	214

TESTING OF LIME JUICE.

This work was first started in 1909 when it was announced that, on the payment of a small fee, planters could have samples of lime juice tested at the Botanic Gardens.

The following table shows the number of samples tested during the last five years :—

Year.	1911.	1912.	1913.	1914.	1915.
No. of samples tested	7	16	26	48	45

QUALITY OF JUICE.

In addition to the testing of these samples two planters were instructed in the method used, with a view of their undertaking the testing of their own juice in future, and two others were supplied with standard solutions. A large quantity of standard solution was also prepared and checked from time to time for the use of Messrs. L. Rose & Co., Ltd., who, during the year, purchased a very large quantity of raw juice from planters and peasant proprietors.

It is reassuring for both parties to know that their juice is bought on a perfectly fair basis.

In cases of dissatisfaction samples are often referred to the laboratory.

IMPROVEMENT IN THE MANUFACTURE OF LIME PRODUCTS.
CONCENTRATED LIME JUICE.

When analysing samples of concentrated lime juice produced on the various estates we are able to form an opinion as to the quality of the product. For several years past we have pointed out the great room for improvement which exists in this direction. Whilst a number of samples examined are all that can be desired, the majority comprise samples which contain far too much sediment.

Purchasers have often complained of the dirty condition of many consignments of Dominica juice, and some have discriminated against buying Dominica juice on that account.

It is obvious that if Dominica is to maintain her place as the leading citric acid producer in the West Indies, attention must be given to the production of clean concentrated juice.

The quality of the juice in this respect is readily determined by the sediment test, which gives the number of units of sediments in 100 c.c. of juice.

In the best prepared samples this may be nil; in many carefully prepared samples it is under 30, but in the majority of samples it is over 100 units.

A concentrated juice testing about 100 oz. of citric acid per gallon, and having a sediment test of not more than 30 units should be the aim of all planters producing concentrated lime juice.

RAW LIME JUICE.

By far the greatest quantity of raw lime juice is handled by one firm who exports a juice of excellent quality, taking every care that it comes up to a certain standard. When other firms buy lime juice for shipment it is desirable that they should satisfy themselves by appropriate tests that what they ship is up to the desired standard so that the good name of Dominica lime juice may be maintained.

LOSS OF ACID IN THE PROCESS OF CONCENTRATION.

Careful experiment has established the fact that when lime juice is concentrated by the open fire method there is a loss of acid under the most favourable condition of at least 10 per cent. of the original acidity. When the juice is highly concentrated this loss is much greater. This fact led two or three planters in Dominica some years ago to concentrate by steam, and of late years this process has been taken up on estates in St. Lucia largely as the result of the successful steam concentration at the St. Lucia Government Lime Juice Factory. During the year under review, at least five additional steam concentration plants were established in Dominica. That the installation of such plants results in a great saving of acid is confirmed by the following experiments which were conducted by A. H. Green, Esq., of Canefield estate, the raw and concentrated juices being tested at this laboratory:—

LOSS BY CONCENTRATION AND MILLING.

Experiment 1. (Steam concentration.)

Citric acid in raw lime juice	
5,400 gallons at 12.54 oz. per gallon	= 67,716 oz.
Citric acid in concentrated lime juice	
578 gallons at 114.5 oz. per gallon	= 66,181 „
Loss during concentration ...	<u>1,535 oz.</u>
	= 2.3 per cent.

Experiment 2. (Steam concentration.)

Citric acid in raw lime juice	
5,400 gallons at 12.54 oz. per gallon	= 67,716 oz.
Citric acid in concentrated lime juice	
597 gallons at 110.0 oz. per gallon	= 65,670 „
Loss during concentration ...	<u>2,046 oz.</u>
	= 3 per cent.

It is evident from these two experiments—and they are confirmed by similar experiments carried on at the Government Lime Juice Factory in St. Lucia—that the loss in concentration when steam is used, amounts to about 3 per cent., and further that this process enables the planter to carry on the concentration to a higher degree thus saving a considerable sum in freight and packages. The installation of steam concentration plants is strongly recommended.

THE EXTRACTION OF LIME JUICE BY MILLING.

A process of estimating the efficiency of lime mill work was devised by the Government Chemist for the Leeward Islands some years ago. A series of determinations was made at the time on several Dominica mills with results which showed that there was considerable waste in this direction on many estates. It was expected that planters would avail themselves of this opportunity of controlling their mill work by sending in samples of skins and juice from time to time. Only one sample was examined in this connexion during the year.

An experiment conducted on an estate showed that with an extraction of slightly over 8 gallons per standard barrel of 4.5 cubic feet, nothing was to be gained by macerating the skins with water and passing them through the mill again. The cost of handling the weak juice would only pay when citric acid was selling at a considerable higher price than the present quotation, viz: £23 per pipe.

ANALYSIS OF MANURES.

The quantity of manure used on estates in Dominica is not very great but it is steadily increasing. That manuring pays on lime cultivation has been conclusively proved by a number of planters who have been in the custom of using manures for many years, and more recently by the experiments conducted at the Lime Experiment Station the results of which are discussed in another section of this report.

It becomes a matter of public importance to investigate the quality of the manures offered for sale. A number of different kinds of manures are used, but only two kinds are applied to any considerable extent, viz:—

1. Poynters, Glasgow, meat bone meal.
2. Swifts, United States America, brand 003.

Commercial samples of these two manures were obtained and analysed in the laboratory with the results shown in the following table:—

MANURES AND MILK.

Manure.	Guaranteed analysis.		Found on analysis.	
	Ammonia, Phosphates,		Ammonia, Phosphates,	
Meat bone meal	7½ per cent.	28 per cent.	8.2 per cent.	32.5 per cent.
Swifts brand 003	8 „ „	25 „ „	8.32 „ „	34.96 „ „

It is satisfactory to note that in both cases the manures are well above the guaranteed analysis. Both manures are very similar in chemical composition, are made from organic matter, and are free from acid. The former manure is possibly slower acting, not being so finely ground. Both have been used for many years in Dominica and can be thoroughly recommended. It should be noted, however, that they do not supply potash, and experiments tend to show that the best crops cannot be obtained without a supply of potash. After the war this aspect of the manuring question should receive the attention of Dominica planters.

Either of these manures should be applied at the rate of not less than 5 cwt. per acre, at a cost of £3.

A sample of sheep manure analysed at the laboratory gave the following results :—

Nitrogen	...	...	1.36 per cent.	= 1.65 per cent.	ammonia.
Phosphoric acid	...	0.65 „ „	= 1.4 „ „		tricalcium phosphate.
Potash	...	...	1.26 „ „	=	

If this manure could be bought at a price under \$8 per ton it would be good value.

In addition, the manures used on the various experiment plots at the Experiment Station were analysed, and the results may be seen in the section of the report dealing with that subject.

THE ROSEAU MILK SUPPLY.

It was only at the latter end of the year that the necessary appliances for conducting milk analyses were received; consequently it was only possible to make one set of determinations. The result of the analyses and the deductions drawn therefrom may be seen in the following report, which was published in the *Dominica Official Gazette* :—

REPORT ON THE ROSEAU MILK SUPPLY.

During the week ending March 4, twelve samples of milk were analysed in the local laboratory; the samples were obtained under the direction of the Chairman of the Roseau Town Board and represented a portion of the milk sold by twelve different licensed milk sellers in the town.

The results of the analysis are given in the table which follows :—

MILK ANALYSIS.

No. of sample.	Total solids.	Fat.	Solids not fat.	Water.	Specific gravity.
1	11.73	2.5	9.23	88.27	1.0334
2	15.01	6.5	8.51	84.99	1.0257
3	12.26	4.1	8.16	87.74	1.0282
4	12.30	4.0	8.30	87.70	1.0281
5	13.64	4.7	8.94	86.36	1.0306
6	11.98	3.5	8.48	88.02	1.0288
7	12.72	4.0	8.72	87.28	1.0301
8	12.75	4.0	8.75	87.25	1.0306
9	17.17	7.7	9.47	82.83	1.0295
10	14.17	5.7	8.47	85.83	1.0287
11	13.31	4.4	8.91	86.69	1.0304
12	11.90	4.4	8.00	88.10	1.0269
Mean 12 samples ...	13.24	4.6	8.66	88.75	1.0292

The legal standard for milk in

1. The United Kingdom is 3 per cent. fat, 8.5 per cent. solids not fat
2. The U.S.A. is 3.25 per cent. fat, 8.5 per cent. solids not fat.
3. Jamaica is 3.5 per cent. fat, 8.25 solids not fat.

A comparison of the results of the analysis of the Roseau milk supply as represented by these samples with the above legal standards shows that a very good quality of milk is offered for sale. One sample only (No. 2) shows a deficiency in fat, even when compared with the high legal standard of Jamaica. By the same standard two samples of (Nos. 3 and 12) show a deficiency in solids other than fat, and in the case of No. 12, water has been added to the extent of 3 per cent.

The mean results of the analysis of the twelve samples are well above the legal standards of the different countries enumerated above.

The very high fat content of sample 9 is probably due to the sample having been taken without due regard to the proper mixing of the milk by the person responsible for collecting the samples.

THE CONCENTRATION OF LIME JUICE BY FREEZING.

INTRODUCTION.

The Commissioner of Agriculture for the West Indies (Dr. Francis Watts, C.M.G.) brought to the notice of the Department an interesting article on the concentration of cider by freezing, which appeared in the Year Book of the United States Department of Agriculture for 1914. In this experiment it was shown that it was possible to concentrate cider by this process to one-fifth of its bulk without altering its properties as a beverage.

Dr. Watts suggested that experiments be conducted to determine the behaviour of raw lime juice when treated in a similar manner. It is obvious that if raw lime juice which is shipped for cordial purposes could be concentrated without changing its essential properties, there would be a very considerable saving in freight, packages and other charges.

CONCENTRATION OF LIME JUICE BY FREEZING.

The phenomenon that solids in solution can be concentrated by freezing the liquid and removing a portion of the ice formed has been known for a long time, and in the reverse way this has often been made use of in obtaining drinkable water from sea-water. In this case it is the frozen portion which is saved, the amount of sodium chloride which it contains being so small as to make it moderately drinkable.

EXPERIMENTS WITH LIME JUICE.

Numerous experiments have been conducted during the year to ascertain how lime juice behaves on freezing, and the results obtained are discussed below.

The raw lime juice throughout these experiments is placed in a receptacle of block tin or a glass jar, which is packed round with a freezing mixture of salt and ice which reaches a temperature of between -5° and -10° C. In a short time the juice becomes cooled to a temperature of between -1° and -2° C. Shortly after it will be found that ice has separated on the side of the jar, and on continuing the process this layer gradually thickens until later a core of juice remains and finally a solid mass is formed.

The sides of the receptacle are now warmed, and the solid mass slips out on to a basin where it is cut up with a knife into pieces of suitable size to enable their being readily placed inside the basket of the centrifugal machine.

The centrifugal is whirled round for a few minutes, and throughout these experiments the whole was melted in stages of known volumes.

The capacity of the centrifugal machine was such that only 500c.c. of juice could be conveniently handled.

A few typical examples of what happens under these conditions and when the juice is completely frozen and allowed to melt within the centrifugal, the latter being kept continually whirled, may now be given.

(1) Test of original juice 13.2 oz. per gallon.*

1st	100 c.c. of juice to melt tested	17.9	oz. per gallon.
2nd	100 c.c. " " " "	26.2	" " "
3rd	100 c.c. " " " "	14.6	" " "
4th	100 c.c. " " " "	4.48	" " "
5th	100 c.c. " " " "	1.79	" " "

(2) Test of original juice 12.5 oz. per gallon.

1st	100 c.c. of juice to melt tested	25.5	oz. per gallon.
2nd	100 c.c. " " " "	23.9	" " "
3rd	100 c.c. " " " "	7.1	" " "
4th	100 c.c. " " " "	2.7	" " "
5th	100 c.c. " " " "	.67	" " "

The second example shows that the first portion to melt is not always weaker than the second.

The difference between the point of concentration in the two typical examples given is probably due to the degree of hardness of the frozen mass.

In another series of experiments the juice was not completely frozen, but a portion varying in volume was left unfrozen.

*To convert oz. per gallon to grains per oz. multiply by 2.734.

CONCENTRATION OF LIME JUICE BY FREEZING.

Typical examples of results under these conditions are :—

(1) Test of original juice 12·72 oz. per gallon.

When 74 per cent. of the bulk is frozen					
130 c.c. not frozen tested 13·9 oz. per gallon.					
1st	140 c.c. to melt	"	22·4	"	"
2nd	50 c.c. " "	"	14·56	"	"
3rd	50 c.c. " "	"	3·7	"	"
4th	50 c.c. " "	"	1·6	"	"
5th	55 c.c. " "	"	·9	"	"

(2) Test of original juice 12·72 oz. per gallon.

When 90 per cent. of the juice is frozen					
50 c.c. not frozen tested 22·3 oz. per gallon.					
1st	50 c.c. to melt	"	18·1	"	"
2nd	100 c.c. " "	"	23·4	"	"
3rd	100 c.c. " "	"	9·1	"	"
4th	100 c.c. " "	"	3·8	"	"
5th	100 c.c. " "	"	2·0	"	"

(3) Test of original juice 12·72 oz. per gallon.

When 96 per cent. of the juice is frozen					
20 c.c. not frozen tested 39·2 " " "					
1st	100 c.c. " "	"	21·4	"	"
2nd	100 c.c. to melt	"	19·8	"	"
3rd	100 c.c. " "	"	8·5	"	"
4th	100 c.c. " "	"	3·57	"	"
5th	100 c.c. " "	"	1·11	"	"

(4) Using 1,000 c. c. of juice testing 12·5 oz. per gallon.

When 95 per cent. of the juice is frozen					
45 c. c. not frozen tested 21·6 oz. per gallon					
1st	200 c. c. to melt	"	28·8	"	"
2nd	200 c. c. " "	"	23·2	"	"
3rd	200 c. c. " "	"	8·2	"	"
4th	200 c. c. " "	"	3·3	"	"
5th	130 c. c. " "	"	·56	"	"

It will be gathered from the above four experiments that it is necessary in order to obtain satisfactory results to freeze the juice almost completely.

Now, if the higher testing juices, say, those over 20 oz. per gallon are refrozen, a further concentration is effected, thus 250 c. c. of the juice to be refrozen testing 22·5 oz per gallon.

1st	100 c. c. to melt tested	29·57	oz. per gallon.
2nd	50 c. c. " "	26·00	" " "
3rd	50 c. c. " "	15·00	" " "
4th	30 c. c. " "	1·5	" " "

By two freezings a juice originally testing 12·7 oz. per gallon may be brought up to a test of about 30 oz. per gallon.

All juices around the test of 14 oz. per gallon obtained by melting would of course be mixed with more of the raw juice. There is no difficulty in refreezing such juices.

The treatment of the rejected weak juices such as those under 10 oz. per gallon have also been investigated, and the following typical experiment shows that it would not be economical to refreeze them :—

PURE CITRIC ACID CONTENT OF LIME JUICE.

170 c. c. of juice testing 5·6 oz. per gallon was completely frozen and as before treated in the centrifugal.

1st	30	c. c.	to melt	tested	8·5	oz.	per	gallon.
2nd	20	c. c.	"	"	10·1	"	"	"
3rd	20	c. c.	"	"	7·0	"	"	"
4th	30	c. c.	"	"	3·8	"	"	"
5th	20	c. c.	"	"	2·35	"	"	"
6th	50	c. c.	"	"	under 2·0	"	"	"

Such juices could be converted into citrate of lime and this seems the best way of dealing with them.

It is thought that the information here put forward is sufficient for those who may be practically interested in the application of the process of concentrating by freezing to arrive at an understanding as to the degree to which the process may be useful in the ordinary work of lime juice production. Should the process appeal to the producers of lime juice, it remains for them to consider how it may best be applied to the work they have in hand, and doubtless they will give this aspect full consideration.

Little difficulty should be experienced in planning the machinery for putting the process into use on a commercial scale, and the officers of the Department will be glad to discuss the matter with those who may be interested.

CONCLUSIONS.

1. Raw lime juice when frozen and treated in the centrifugal can be concentrated without affecting its properties as a beverage.
2. If the juice is treated once only, the acid content may be increased from about 13 oz. per gallon to over 20 oz. per gallon.
3. If this be refrozen a juice containing 30 oz. per gallon can be obtained.
4. The low testing juices can be converted into citrate of lime, thus eliminating all losses excepting those of handling.
5. This process enables a very considerable saving to be made in freight, charges and packages, amounting to between 40 and 60 per cent., the actual amount depending on whether the juice is frozen once or twice.

CITRIC ACID CONTENT OF RAW AND CONCENTRATED LIME JUICE.

During the year 1914-15, it became the duty of the writer to detect and to estimate the losses occurring in the manufacture of citrate of lime from raw lime juice. The investigation in this connexion led to an enquiry into the citric acid content of raw and concentrated juices. The results of this latter investigation are presented below.

Fresh lime juice, like lemon juice, contains citric acid; acids other than citric; citrates; salts of organic acids other than citric salts of organic acids such as potash and phosphoric acid; and albuminous and mucilaginous substances. In addition there is a considerable quantity of pulp floating in suspension, and a small quantity of essential oil pressed from the rind during the process of milling.

On keeping for any length of time fermentation sets in, principally due to moulds, which results in the destruction of some of the acid and the liberation of carbonic acid gas. The presence of oil in the juice prevents to a large extent this fermentation, hence the anxiety of firms buying raw lime juice for the preparation of beverages to obtain juice from unecuelled limes.

Pure citric acid crystals are assumed to have the composition $C_6H_8O_7 \cdot H_2O$ with the molecular weight of 210; formerly there was some doubt on this point, and for commercial purposes the basis 201 was adopted, being equivalent to

PURE CITRIC ACID CONTENT OF LIME JUICE.

$C_6H_8O_7 \cdot \frac{1}{2}H_2O$ and this is the equivalent still adopted by the trade in analysis of citric acid solutions, whilst in the case of citrate of lime the Warington determination is carried out and the solutions made up on the basis of citric acid 210*.

Of the constituents of raw juice the only ones of importance to the citric acid producer are the citric acid and the citrates. The usual method of testing raw lime juice by titration with standard alkali is not entirely reliable, as such a determination would include acids other than citric when present, but would take no account of any possible citrates. In order to determine the relationship between total acidity and pure citric acid obtainable from raw lime juice, twenty-four samples of fresh raw juice from various districts in the island were analysed by the Warington method. (See *West Indian Bulletin*, Vol. XIV, p. 186.)

In making the determination for total acids by simple titration against normal NaOH. care was taken to keep the caustic soda solution as free as possible from carbonates, and as a further precaution, after the addition of about 95 per cent. of the alkali required for complete saturation, the solution was carefully boiled for a few minutes and allowed to cool before completing the neutralization.

In this laboratory when testing lime juice it has been customary to use phenol-phthalein as indicator. In some instances workers in other laboratories use litmus paper.† Numerous determinations by the writer show a very considerable difference in the readings when these two indicators are used, amounting on an average to 2 per cent. of the total acidity present, the litmus showing the lower reading to this extent. Observations made tend to show that for the determination of the total acidity present phenol-phthalein gives the more accurate reading and this indicator has been used throughout these determinations.

Of the twenty-four samples analysed one showed 100 per cent. of precipitable citric acid to total acidity; three others contained over 99 per cent; the lowest showed 96.85 per cent. The mean for the twenty-four samples was 98.34 per cent. Fresh raw juice appears therefore to contain acids other than citric to the extent of about 2 per cent.

CONCENTRATED LIME JUICE.

In order to reduce the cost of transport, raw lime juice is concentrated before shipping. This is done in two ways; by the open fire method and in steam-heated vats. By the first method a considerable destruction of acid takes place amounting to about 10 per cent.; by the second process this loss is reduced to under 3 per cent. of the original acid. (See *West Indian Bulletin*, Vol. XII, p. 465.)

Twenty-two samples of concentrated juice have been analysed for total acidity and citric acid content. As before, the alkaline solution was made up on the basis of citric acid 210. The remarks concerning indicators hold good to the same extent in concentrated lime juice as in raw juice. The highest percentage of citric acid to total acidity was 99.3, and the lowest 94.0. The mean for the twenty two samples was 97.51 per cent.

The practice of analysing concentrated juice by simple titration and reckoning on the equivalent of 201, which is the method stated to be used in the trade, does not give an accurate determination of the amount of citric acid present. By this method the producer of citric acid may lose as much as 3 per cent. of the citric acid present. It may be pointed out that the juice containing the low ratio of total citric acid to acidity is mainly produced by a section of the island which at present yields only a very small proportion of Dominica's output.

The loss is magnified further if the analyst uses litmus as indicator, and may total up to 5 per cent. As is recognized by Messrs. Ogston & Moore in a com-

* See however the recommendations made by the Committee appointed by the Italian Board of Agriculture concerning the analysis of citrate of lime and of lemon juice. The use of the factor 210 is recommended in all cases. (See *West Indian Bulletin*, Vol. XIV, p. 186.)

† The remarks re litmus paper refer to the ordinary litmus paper. Warington has shown that litmus paper specially prepared when held in the solution, for half a minute is sensitive to 1 part of citric acid in 70,000 of water. (See *Jour. Chem. Socy.* October 1875.)

PURE CITRIC ACID CONTENT OF LIME JUICE.

munication to the Committee appointed by the Italian Board of Agriculture, the determination of citric acid by precipitation, as recommended by the above committee, is much more scientific, and it certainly would be more satisfactory to the producer of concentrated lime juice in the West Indies.

Table showing the total acidity, citric acid precipitable by Warington method, and the ratio of citric acid to 100 total free acid on the 210 basis.

A. IN RAW LIME JUICE.

No. of sample.	Total acidity in oz. per gallon by titration.	Total citric acid by the Warington method, oz. per gallon.	Ratio of citric acid to 100 total free acid.
1	13.26	12.90	97.29
2	12.90	12.90	100.00
3	13.36	12.92	97.35
4	13.01	12.77	98.10
5	13.82	13.02	97.72
6	12.96	12.84	99.06
7	12.46	12.27	98.58
8	12.86	12.73	98.95
9	12.76	12.63	98.95
10	12.10	11.99	99.06
11	12.27	12.05	98.17
12	12.86	12.73	98.95
13	12.81	12.63	98.58
14	12.77	12.63	98.95
15	12.14	12.01	98.95
16	12.41	12.27	98.93
17	12.48	12.33	98.63
18	13.67	13.51	98.86
19	11.55	11.52	99.61
20	11.53	11.39	98.70
21	11.74	11.49	97.83
22	12.47	12.06	96.72
23	12.23	11.75	96.07
24	12.10	11.61	95.92

PURE CITRIC ACID CONTENT OF LIME JUICE.

B. IN CONCENTRATED LIME JUICE.

No. of sample.	Total acidity in oz. per gallon by titration.	Total citric acid by the Warington method, oz. per gallon.	Ratio of citric acid to 100 total free acid.
1	110.4	108.5	98.54
2	105.3	101.7	96.58
3	108.4	104.4	96.29
4	106.4	104.4	98.13
5	146.8	143.8	98.00
6	113.8	109.4	96.32
7	131.7	130.4	99.00
8	96.79	95.19	98.35
9	111.1	110.3	99.17
10	99.02	98.0	98.97
11	119.5	117.4	98.24
12	99.33	98.11	98.74
13	...	...	98.22
14	95.19	93.28	98.00
15	84.24	82.43	97.86
16	108.4	104.2	96.16
17	105.7	101.7	96.18
18	84.68	82.0	96.83
19	103.0	99.15	96.01
20	97.45	94.54	97.03
21	101.5	96.11	94.69
22	93.63	88.04	94.04
23	101.1	100.4	99.31

THE ROSEAU WATER-SUPPLY.

The following is a report by Dr. Tempany, Government Chemist for the Leeward Islands, on the Roseau water-supply :—

‘I have the honour to submit herewith a report on three samples of water taken from the public supply of the Town of Roseau, Dominica, in compliance with a verbal request made to me by His Honour the Administrator of Dominica, that a careful analytical examination should be made of the supply in question.

COMPOSITION OF DOMINICA WATER.

The samples were drawn by Mr. G. A. Jones, Assistant Curator and Assistant Chemist to the Dominica Department of Agriculture; they were derived from the following sources :—

No. 1.—From the tap in the laboratory at the Botanic Gardens, Roseau;

No. 2.—From the intake of the reservior.

No. 3.—From the Sweet River at the point where it leaves the forest.

The samples were analytically examined in the Laboratory by myself; the results obtained from the examination are annexed in tabular form.

The results in the case of all the samples are in very close agreement and indicate that the waters must be regarded *as of considerable purity and showing no evidences of appreciable pollution*. It may perhaps be remarked that the albuminoid ammonia content is slightly higher in the case of samples Nos. 1 and 2 than in that of sample No. 3.

It is also worthy of remark that although the total solids content is low, there is a marked difference between the sum of the contents of sodium chloride and temporary hardness and the total solids. Examination of the waters for sulphates showing them to be practically free from this constituent, and there is presumptive evidence to show that the difference in question may be due to soluble silica.

In reviewing those results it should be remembered that the volume of flow from a supply of this type is bound to vary very largely with seasonable conditions, and that the character of the water may vary quite considerably in consequence; the present set of samples were taken during the wet season, in order to provide a complete check it would be desirable that a similar set of samples should be taken during a period of dry weather of some duration.

	1 From Roseau.		2 From Intake.		3 From Fores.	
	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallons.	Parts per 100,000.	Grains per gallon.
Total solids	16·4	11·5	17·6	12·3	16·0	11·2
Chlorine	1·6	1·1	1·4	1·0	1·3	0·9
Equivalent sodium chloride...	2·6	1·8	2·3	1·6	2·1	1·5
Temporary hardness ...	3·0	2·1	3·1	2·2	3·2	2·2
Permanent „	nil	nil	nil	nil	nil	nil
Nitrates	nil	nil	nil	nil	nil	nil
Free Ammonia	trace	trace	trace	trace	trace	trace
Albuminoid	·0024	·0017	·0020	·0014	·0010	·0007
Oxygen absorbed in 25 mins.	·016	·011	·023	·016	·014	·010
„ „ in 4 hrs..	·071	0·497	·055	·0385	·056	·0392

DOMINICA WATER.

REPORT ON TWO SAMPLES OF WATER FROM SOUFRIERE, DOMINICA.

Dr. Tempany's report on the Soufrière water-supply is as follows :—

REPORT ON TWO SAMPLES OF WATER FROM SOUFRIERE, DOMINICA.

I beg to submit the following report on two samples of water from the public drinking water supply of Soufrière, Dominica, submitted for analysis by His Honour the Administrator of that Presidency.

The samples were marked No. 1 "Source" and No. 2 "Exit" respectively. The samples had obviously been carefully taken, they were properly put up in bottles contained in the water sample case provided for that purpose and labelled distinctly.

The results of the examination are as follows :—

	No. 1 From Source grs. gall.	No. 2 From Outlet grs. gall.
Total solids	31·5	30·0
Chlorine	4·3	4·8
Equivalent sodium chloride ...	7·1	8·0
Temporary hardness	7·8	8·1
Permanent hardness	2·8	4·2
Nitrates	nil	nil
Poisonous metals	nil	nil
Ammonia free	0·0017	trace
Albuminoid	0·0008	0·0008
Oxygen absorbed in 20 minutes	·005	·007
4 hours	·007	·007

From the point of view of the contained organic matter as judged by the oxygen absorption and the ammonia content, the water is of a very high degree of purity.

The total dissolved mineral matter is somewhat higher than usual but is not sufficiently high to be in any degree objectionable.

As judged by these two samples the quality of the water-supply appears to be on the whole satisfactory.

Work Connected with Insect and Fungus Pests and Their Control.

It will be remembered that during 1914-15 Mr. W. Nowell the Mycologist on the staff of the Imperial Department of Agriculture spent a considerable amount of time in investigating the causes and distribution of the so-called Black Root disease on limes in Dominica.

A preliminary report was prepared and reproduced in last year's progress report. During the year under review these investigations were continued and in August last there was published by the Imperial Department a pamphlet (No. 79) entitled 'Diseases of Lime trees in Forest Districts.'

A large number of copies of this pamphlet was purchased by the local Government and distributed widely in Dominica free of charge.

It is not necessary here to reproduce any part of the pamphlet, but it may be stated that one of the chief duties of the staff when travelling is to be on the look out for these diseases and to impress upon the estate management the importance of treating thoroughly any outbreak noticed. The advice is not always followed and in one instance where the red root disease has been rampant for close on four years even to-day it is not uncommon to find diseased stumps lying about the field and isolation trenches not dug. Under these conditions the spread of the disease is to be anticipated.

The investigation of the disease is not regarded as concluded. Three areas are under close observation with a view of determining the rate of spread of the disease, and the efficiency of various remedial measures suggested. These areas contain 100 trees each and are situated on three estates. They have been examined on three separate occasions at intervals and further valuable information may be expected.

It was at one time feared that the red root disease had broken out in a new district of the island, but a careful examination by the Mycologist failed to confirm this and though a certain number of trees are dying, their death cannot be attributed to this cause.

It may be of interest to place on record the fact that a sour orange stock was found badly attacked by the red root disease on an estate in the interior. Whilst the sour orange is undoubtedly far more resistant to root diseases than the lime it cannot be claimed for it that it is immune from attack.

Report on Agricultural Instruction at the Botanic and Experiment Station.

It was in July 1911 that the Agricultural School which was maintained by the Imperial Government at a cost of about £600 per annum was closed down as regards the boarding of the pupils, and a modified scheme of agricultural instruction instituted at the Botanic Gardens, the cost of which does not exceed £200 per annum.

The present system of training has therefore been in force close on five years and this offers a favourable opportunity of reviewing the work done during this period.

The former Agricultural School ran for a term of ten years. The staff consisted of an officer-in-charge and a school master, who devoted all their time to the training of the boys. The pupils were fed, housed and clothed free of charge to their parents for a period of three years and there were on an average twenty boys in training. Six well trained and well educated boys were turned out from the school annually, and as this appeared to be more than the agricultural requirements of the island, a number of the boys were unable to obtain employment on estates and either left the island or took up appointments as clerks in stores, etc. and their services were thus lost to the agricultural community.

Owing to lack of facilities, the practical side of their training was defective especially in the cultivation of the main crops of the island—limes and cacao—and there may have been some justification for the complaints of planters that the boys were more theoretical than practical in their attainments, and for this and other reasons there was a tendency for planters not to favour these boys as candidates when vacancies occurred on their estates.

Largely on this account and for reasons of economy the whole system of training was changed in 1911; the method now in force may be gathered from the following circular which is annually distributed throughout the Island :—

TRAINING OF PUPILS.

1. The Agricultural Department is prepared to receive a limited number of pupils for practical training in agriculture.

2. The course of training will extend over a period of two years, and pupils will be required to engage in the various branches of field and nursery work with a view of acquiring a sound knowledge of practical agriculture.

3. Candidates must be at least sixteen years of age, healthy, and physically fit, and have shown aptitude for instruction in agriculture. They must have attained a standard of elementary education corresponding to the sixth standard of the Primary School, or sufficient to satisfy the Agricultural Superintendent that they are capable of taking full advantage of the course of training offered. They must be youths of good character and be recommended by a responsible person.

4. Subject to good behaviour and satisfactory progress in their work, pupils will be granted an allowance beginning with 3s. 6d. per week and advancing to 4s. per week in the second half year, 4s. 6d. in the third, and 5s. in the fourth half year of their training. Pupils whose conduct and progress are unsatisfactory will not be retained under instruction.

5. Where the parents or guardians of any accepted pupil do not reside within the limits of Roseau, the propriety of the grant of a small additional allowance towards the expenses of the pupils residence within easy access of the Botanic Station will be considered.

6. The course of instruction will be directed towards the acquirement of a practical knowledge of the methods of plant propagation, nursery work, planting and care of staple crops such as limes, oranges, cacao, rubber, vanilla, fruits, and the commonly cultivated provision crops. The course will include instruction and practical work in the various forms of tillage, drainage, weeding, sowing seeds, transplanting, use and application of manures and mulches; the treatment of insect and fungoid pests, pruning, budding, grafting, packing, transporting and planting out young lime plants; picking, preparing, and packing crops for market, etc.

7. In addition to the practical instruction and the carrying out of the above outlined work at the Botanic and Experiment Stations, the pupils will receive an appropriate amount of class instruction in the fundamental principles underlying the practical work. They will also be required to undertake a prescribed amount of home reading and study under the direction of the Agricultural Superintendent.

AGRICULTURAL INSTRUCTION.

8. Application for admission of candidates must be made on forms to be obtained from the Agricultural Superintendent.

The number of pupils retained is usually six and as the period of training extends over two years three boys are annually received into training and three complete their training and are available for work on estates. The change of pupils takes place in July of each year as at that period planters are as a rule on the look out for overseers for the crop season and it affords an opportunity for a boy to show what is in him.

The essential difference in the training given at the present time is that most of the time of the boys is given to practical field work, the class teaching being confined to Saturday mornings.

The extensive nurseries, and the cacao and lime experiment stations run by the Department afford splendid opportunities for teaching the boys, and they in their turn do useful work in assisting in carrying on the work.

In order to show the nature of the field work done by the pupils the following extracts from the diaries of one of them are reproduced. It may be mentioned that at the close of each day the boys meet in the class room and enter up in their diaries the work done during the day.

APRIL.—Pruning lime trees in the new Lime Experiment plots in the valley. Opening holes for lime plants; preparing rosin compound, and spraying nurseries. Tapping *Castilloa* rubber trees; tarring posts for fences.

MAY.—Spraying citrus and ornamental plants, preparing insecticides, sowing cacao seeds, preparing bamboo pots, pruning cacao trees. Topping hedges; pollinating vanilla flowers; collecting material for mulching cacao plots.

JUNE.—Preparing for application of manures to cacao manurial plots at the station, weighing different manures per plot, and per tree. Applying manures. Gathering seeds of green dressings; budding lemons on sour orange stocks. Pruning cacao trees; applying manures to lime experiment plots; tarring gates in experiment plots; picking cacao and removing suckers.

JULY.—Sowing lime seeds. Planting cuttings of shade trees; sowing seeds of green dressings through coconut plot. Topping hedges; applying manures; tapping *Castilloa* rubber trees; preparing insecticides and spraying nurseries.

AUGUST.—Lining out for planting lime plants in new Experiment Station. Spraying lime plants; picking and suckering cacao; preparing a fungicide, and applying to seedling limes. Potting cacao seedlings; spraying lime plants, and transplanting lime seedlings; preparing stock solution of rosin compound; budding lemons on sour orange stocks; applying lime to heavy land.

SEPTEMBER.—Transplanting lime seedlings. Sowing seeds of green dressings in the nursery. Trimming hedges; spraying lime seedlings; suckering cacao; potting cacao seedlings. Preparing Bordeaux mixture; planting lemon grass on poor soil to produce mulch for experiment plots. Dressing cacao trees for "canker." Poisoning wood-ant nests in cacao cultivation. Preparing seed boxes and sowing seeds.

OCTOBER.—Potting cacao seedlings. Sowing seeds of green dressings, suckering cacao and treating wounds on cacao trees with tar. Weeding and mulching young coconuts. Tarring posts exposed to weather. Surveying and enclosing two new cacao manurial plots; mulching Para rubber trees; preparing bamboo pots; removing moss and other epiphytes from citrus trees. Mulching young limes planted in experiment plots. Lifting and transplanting sour orange stocks for budding. Tapping *Castilloa* rubber trees; transplanting lime seedlings.

NOVEMBER.—Transplanting lime seedlings; sowing seeds of tangerine, mangoes, and avocado pears. Weeding borders and trimming hedges. Picking

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vegetable seeds; potting cacao seedlings. Planting hedges of *Acalypha*. Planting cuttings of *Gliricidia maculata*. Picking and suckering cacao. Weeding green dressings plots.

DECEMBER.—Transplanting lime seedlings; sowing seeds of ornamental plants in boxes; preparing stock solution of kerosene emulsion; spraying limes and cacao. Potting cacao seedlings. Picking cacao; sowing lime seeds in beds; weeding lemon grass plots; spraying cacao for attack of thrips. Sowing cacao seeds. Poisoning wood-ant nests.

JANUARY.—Pruning dead wood in lime trees. Suckering and picking cacao. Preparing stock solution of kerosene emulsion; spraying limes and cacao. Weeding green dressings plots. Preparing seed boxes and sowing lime seeds. Tapping *Castilloa* rubber trees; sowings seed in boxes.

FEBRUARY.—Transplanting lime seedlings. Sowing lime seeds. Picking and suckering cacao. Gathering seeds of green dressings. Preparing stock solution of rosin compound.

MARCH. Transplanting lime seedlings. Dusting lime seedlings with sulphur and lime. Applying manure to cacao. Spraying citrus nurseries. Sowing lime seeds; trimming hedges; mulching and spraying young limes in new experiment plots. Preparing seed boxes and sowing cacao seeds. Pollinating vanilla flowers. Preparing stock solution of 'scalo.' Pruning lime trees in the Experiment Station.

At the request of the Commissioner of Agriculture, the Hon. J. C. Macintyre of Hampstead estate undertook in 1912 to examine and to report on the practical work of the pupils. After his visit Mr. Macintyre reported as follows:—

'I beg to report that on January 23, I went to Morne Bruce and in the company with Mr. J. Jones inspected the nurseries attached to the Agricultural Department and watched the boys at work in the lime nursery. The following day I visited the Botanic Station, and, accompanied by Mr. G. A. Jones, inspected the work which had from time to time been done by the boys. Both Mr. J. Jones and Mr. G. A. Jones gave me the fullest information as to the system adopted in the training of the boys, and as the scope of their work.

'I am satisfied that the training which the boys were receiving is as practical and as thorough as it is possible to make it under present conditions, and that the value of that training will be considerably enhanced when it is found possible to set the boys to work in the new lime experiment station which, I understand, it is proposed soon to add to the Department. The system of keeping the boys at work under careful supervision daily from Monday to Friday, and of reviewing their work in the class room on Saturday seems to me to be a very great improvement on the old system, and I can make no suggestion for improving it. All the work which I inspected bore evidence of care and thoroughness.'

Mr. Macintyre's testimony as to the practical nature of the work should go far to remove the prejudice which still exists in the minds of many planters against boys trained at the Botanic Gardens.

CLASS WORK.

As has been already stated Saturday morning is confined entirely to class work. The pupils' diaries and note books are corrected and the field work of the week is reviewed and explained. The boys are taken through the following syllabus which was first drawn out for the use of candidates for the reading courses of the Imperial Department of Agriculture.

The atmosphere and the gases composing it. Water and its properties. The chemical and physical properties of sand, clay, chalk and humus. The classification

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of soils. The functions of plant food and water. Drainage of soil. The construction and use of one form of plough, of subsoiler, and of cultivator. Tillage and its effects. The preparation and properties and chief constituents of farmyard manure. The properties and uses of common artificial manures and of lime. Green dressings and organic manures. Micro-organisms in soil and in relation to leguminous plants.

Seeds: their structure and germination. The naked eye structure, and the outlines of the microscopic structure of the root, stem, leaf, flower and fruit of a plant.

Assimilation, transpiration, and respiration in plants. Plant food. The absorption and movement of water in plants.

The propagation of plants by cuttings, by grafting and by budding. Pollination and fertilization.

The Commissioner of Agriculture conducts half-yearly written examinations which help materially in keeping the boys interested and arousing a spirit of competition.

SELECTING CANDIDATES.

There is quite a keen desire on the part of parents to have their sons trained at the Gardens and we are indebted to the head teachers of the country schools who bring to the notice of likely candidates the advantages of entering for training. On an average twelve candidates present themselves at the competitive entrance examination annually. Many of these are hopelessly backward, and should not have been sent up by their teachers; but as a rule four or five are fairly good and three are finally selected. Preference is given to the sons of peasant proprietors.

DESTINATION OF TRAINED PUPILS.

Having completed their two years of training the majority of the pupils leave the Department to take up positions on estates. The ideal position for such a boy would be that of under overseer on a fairly big estate: such a position he should be able to fill satisfactorily. It is too much to expect these boys to be able to do the work of a trained overseer which involves considerable experience in various directions, more particularly in the handling of labour. This is probably the weakest point of their training and the planter should regard them as material for making efficient overseers and be prepared to train them accordingly.

The most promising boy of each year is usually retained in the Department for another two years. During the first year he is appointed clerical assistant to the Curator and the second year, if he continues to show promise, is appointed overseer in connexion with Agricultural Instruction and in that capacity is responsible for the field work of the other agricultural pupils. These additionally trained young men are naturally better equipped than the ordinary pupils, and should give better satisfaction.

It is interesting to place on record the destination of each pupil on leaving the Botanic Gardens and, though the Department is not responsible for them after they get a fair start on an estate, attempts have been made to trace the boys at the present time. This information is now given:—

- | | |
|-----------------------|---|
| 1. G. de Lachevotier. | Old Agricultural school boy. First overseer at the Botanic Gardens. Now overseer Agricultural Department, Northern Nigeria. |
| 2. Alexander Thorpe. | Old Agricultural school boy completed training as pupil, appointed office assistant, now in U.S.A. |

EXHIBITION COMMITTEE.

3. Harry Cuffy.	Appointed overseer Canefield estate.
4. Philip Denis.	" " Malgretout "
5. Paul Benjamin.	" " Somerset "
6. Artley Frank.	last heard of in St. Lucia. Appointed clerical assistant, later overseer Agricultural Department, now overseer Belfast estate.
7. Wilfred Andrew.	Discharged for not making satisfactory progress.
8. Vincent Laronde.	Appointed overseer Rosalia estate.
9. Fadelle Lawrence.	" " Castle Bruce "
10. Stanley Jules.	" " Goodwill "
11. Emile Joseph.	Appointed clerical assistant and now holds the post of overseer, Agricultural Department.
12. George Anselm.	Did not complete training; now overseer Bagatelle estate.
13. Gorvey Cuffy.	Left after twelve months training; now overseer Badineau estate.
14. Musgrave Edwards.	Discharged for lack of interest.
15. William Hutton.	Appointed clerical assistant, Agricultural Department.

PERMANENT EXHIBITION COMMITTEE.

It was decided that under the present conditions Dominica would not participate in Exhibitions, consequently the work of the Permanent Exhibition Committee was practically suspended throughout the year.

During the latter half of the year a suggestion was put forward to the Government that the vote might be utilized in sending fruit, more particularly limes, to the military hospitals thus serving two useful purposes viz:—supplying the hospitals with fruit and familiarizing the British public with fresh limes. The suggestion met with the approval of the Government, and the Curator, as Secretary of the Committee, was instructed to make the necessary arrangements.

Owing to unavoidable delay it was found possible to get together the necessary boxes and packing paper. During the coming year it is hoped to ship a quantity of fruit provided steamer accommodation is available.

THE VICTORIA MUSEUM.

During the year the Assistant Curator and Chemist was appointed a member of the Board of Directors of the Victoria Museum by His Honour, The Administrator and later was made Hon. Treasurer of the Institution.

As time permitted that part of the Museum which is under the care of the Agricultural Department received attention and a few additional exhibits were placed in the Museum.

It may be here mentioned that the Museum lost the services of a most energetic member of the Board of Directors through the death of Mr. E. A. Agar, the Honorary Secretary. The success of the Museum has been largely due to his untiring interest.

EXPENDITURE, ETC.

Details of Administration.

EXPENDITURE, RECEIPTS, ETC.

The votes for the Agricultural Department for the year from local funds were as follows :—

	£	s.	d.
Salaries, Curator, Assistant Curator and Chemist, Junior Assistant			
Curator and Foreman	742	0	0
Travelling expenses	50	0	0
Maintenance, Botanic Gardens	280	0	0
Cultivation of saleable products	240	0	0
Fumigation of imported plants	5	0	0
Testing lime juice	5	0	0
Maintenance, Public Gardens	15	0	0
Purchase of pony	20	0	0
Telephone rental	8	0	0
Purchase of special manures	30	0	0
Printing reports, etc.	25	0	0
Cacao Prize Holdings Competition	25	0	0
Lime cultivation experiments	120	0	0
Purchase of vegetable seeds	15	0	0
Trial shipments of fruit	20	0	0
Field experiments	20	0	0
Chemicals and apparatus	50	0	0
Contingencies	10	0	0
Total	£1,680	0	0

The actual expenditure during the year under the above heads was £1,395 6s. 5d. Owing to the increased cost of manures chemicals and apparatus, and to the repair of damage caused by the storm, it was necessary to apply for further sums under those heads amounting in all to £72 1s. 6d, thus making a total expenditure of £1,467 7s. 11d.

The receipts from sales of cured cacao, plants, fruits and seeds amounted to £529 3s. 4d. This sum was paid into the Treasury as part of the general revenue. By setting receipts against expenditure it will be seen that the net cost of the Agricultural Department was £938 4s. 7d. This represents a charge of slightly less than $\frac{1}{2}$ of 1 per cent. on the value of the agricultural produce imported during 1915.

The grant to meet the cost of training agricultural pupils was £195 of which £174 13s. 4d. was expended.

The amount available for Special Services on April 1, 1915 was £116 17s. This sum was formed of lapsed balances on the Imperial Grant for the Agricultural Department in former years. It is controlled by the Imperial Commissioner of Agriculture, who may, from time to time, recommend for the approval of the Secretary of State, expenditure from this source for the purpose of adding to the

DETAILS OF ADMINISTRATION.

equipment of the Agricultural Department, and in special work in connexion with with agricultural experiments. The following payments were authorized during 1915-16 :—

	£	s.	d.
Meteorological instruments and scientific apparatus for laboratory ...	47	0	1
Lime experiments	19	19	11
Importation of plants	3	14	0
	£70	14	0

STAFF CHANGES.

Mr. G. A. Jones, the Assistant Curator, was offered and accepted the additional office of Chemist in the local Department the appointment dating from April 1, 1915.

Provision was made on the 1915-16 estimates for an additional officer to undertake the duties of Junior Assistant Curator. Under present circumstances this latter appointment has not been filled.

H. A. Frank, Overseer in connexion with Agricultural Instruction obtained a post as overseer on an estate and left the services of the Department in August

E. B. Joseph, Office Assistant, succeeded to the appointment of Overseer.

W. G. Hutton, Agricultural pupil was appointed Office Assistant.

ADDITIONS AND REPAIRS TO BUILDINGS, NURSERIES, ETC.

A vote of £20 was made by the Government early in the year to make temporary arrangements for the carrying on of chemical work.

The quarters occupied by the Assistant Curator and Chemist at Morne Bruce were repaired and painted. Similar work was carried on in connexion with the quarters occupied by the Overseer.

The sides of the buildings at the Botanic Gardens received one coat of paint.

The three latter improvements were carried on under the direction of the Public Works Department.

CORRESPONDENCE AND DISTRIBUTION OF INFORMATION
ON AGRICULTURAL MATTERS.

During the year 1,028 letters were despatched from the office of the Department, and 95 minute papers were dealt with. Sixty-six copies of the *West Indian Bulletin*, and 160 copies of the Annual Report of the Agricultural Department for 1914-15 were distributed free of charge to leading planters, officials, and others in the island.

In addition the local Government purchased 150 copies of a new pamphlet entitled 'Root Diseases in Forest Districts.' These were distributed free of charge to all persons connected with agriculture in the island. A few copies remain on hand and are available for future distribution.

A large number of planters and others desiring information on agricultural matters visited the Gardens during the year.

VISITS TO ESTATES.

No books were added to the Library during the year; but the publication of a number of tropical Agricultural Departments were duly received and bound together. This opportunity is taken of thanking those departments who kindly forward their publications to this department.

The books in the Library are available for reference within the office, but it is a matter of regret that there is a no separate room for housing the Library, where planters and others could quietly consult the fair number of books to be found on the shelves.

VISITS TO ESTATES.

The following estates were visited by officers of the Department during 1914-15: Sherwood, Harris, Saltoun, Brantridge, Riversdale, Gleau Manioc, Stonehill, Sylvania, Corona, Neba, Jacqueau, Layou Park, Clark Hall, Hillsborough, Canefield, Soufrière, Castle Comfort, Point Mulâtre, Stowe, Geneva, St. Aroment, Bath, La Haut, Lisdara, Perdu Temp, Hatton Garden, Melville Hall, Governor, Lyons, Londonderry, Eden, Woodford Hill, Hampstead, Long Ditton, Bagatelle, Soufrière, Castille, and South Chiltern. In addition a large number of small holdings in the Grand Bay district were visited.

These visits enable the Department to keep in touch with the planters and to study their requirements and difficulties and to give advice on agricultural matters generally. The services of the officers of the department are always available when sought by planters in this direction.

The thanks of the Department are tendered for the kind hospitality of planters during these visits.

PLANT AND SEED EXCHANGES, FOREIGN AND LOCAL.

Contributions of seeds and plants were received from the following: The Imperial Commissioner of Agriculture; Royal Botanic Gardens, Kew; United States Department of Agriculture; Royal Botanic Gardens, Ceylon; Royal Botanic Gardens, Trinidad; Botanic Gardens, Buitenzorg, Java; Department of Agriculture, Jamaica; The Agricultural Departments of Northern Nigeria, St. Lucia, Antigua, and Montserrat; also from the Hon. Dr. Nicholls, C.M.G.

Seeds and plants were sent to: The Imperial Commissioner of Agriculture; Royal Botanic Gardens, Kew; United States Department of Agriculture; Royal Botanic Gardens, Trinidad; Hope Gardens, Jamaica; The Agricultural Departments of Grenada, St. Lucia, St. Vincent, Antigua, Tortola, Guadeloupe, Southern Nigeria, Sierra Leone, Fiji, Madagascar, British East Africa; and also to the Rev. Father Duss, Martinique; R. S. Cunliffe, Esq. Cuba; A. W. Reid, Esq. Bermuda; A. Giraud Esq., French Consular Agent, Roseau; Hon. W. M. Wigley, St. Kitts; The Hon. J. C. Macintyre, and also to Hon. Dr. Nicholls, C.M.G.

VISITS BY OFFICIALS OF THE DEPARTMENT.

The Hon. Dr. Francis Watts, C.M.G., Imperial Commissioner of Agriculture for the West Indies, arrived in Dominica on May 6 and left for St. Kitts the following day.

OFFICIAL AND OTHER VISITS TO THE GARDENS.

During his visits he inspected the Botanic Gardens and the Experiment Station. On his return journey from St. Kitts, Dr. Watts remained in the island for nine days—May 21 to 30. During his stay he paid frequent visits to the Botanic Gardens and Experiment Station, consulted the Government on matters connected with agriculture and paid visits to several estates.

Dr. Watts paid short visits to the island on the following dates: June 7, January 29, February 5, and March 21 when in transit between the islands.

On each occasion the opportunity was taken of consulting Dr. Watts on agricultural matters.

Dr. H. A. Tempany, Superintendent of Agriculture for the Leeward Islands, visited Dominica from August 21 to the 27.

Mr. W. Nowell, D.L.C., Mycologist on the staff of the Imperial Department of Agriculture, spent seventeen days from May 21 to June 7 in Dominica, continuing his investigation into the causes and distribution of the fungus diseases attacking limes.

Mr. Nowell paid two additional brief visits when on his way to the Northern Islands, viz. July 12 and March 21.

Mr. Ballou, M.Sc., the Entomologist on the staff of the Imperial Department of Agriculture also paid two brief visits to Dominica.

Mr. W. R. Dunlop, Scientific Assistant to the Commissioner of Agriculture, and Mr. S. C. Harland, B.Sc., Assistant Superintendent of Agriculture, St. Vincent, spent a day in Dominica on March 21.

OTHER VISITS.

Sir Gilbert Carter, K.C.M.G., visited the Gardens on November 30.

His Honour Major Burdon, C.M.G., Administrator of St. Kitts-Nevis, paid a visit to the Gardens in company with His Honour the Administrator of Dominica.

The Hon. G. Murray, C.M.G., Administrator of St. Lucia paid a brief visit to the Gardens.

The Hon'ble T. E. Fell, Colonial Secretary of Barbados accompanied by Dr. Watts, visited the Gardens on March 21.

W. G. Freeman, Esq., B.Sc., Assistant Director of Agriculture, Trinidad, and J. B. Rorer, Esq., M.A., Mycologist, Board of Agriculture Trinidad were also visitors at the Gardens.

A. J. Brooks, Esq., Agricultural Superintendent St. Lucia, spent three weeks in the island and frequently visited the Botanic Gardens and Experiment Station.

Messrs. W. Robson and W. C. Fishlock, of Montserrat, and the Virgin Islands, respectively, called at the Gardens during the period under review.

Mons. Pierre Thollard, Head of the recently established Agricultural Department in Guadeloupe, spent several days in Dominica and was given information as to the working of the Agricultural Department and supplied with a number of plants.

Mr. Driver, formerly of the Montserrat Company, Mr. McLeod of Trinidad, and Mr. F. E. Wahy, formerly of the Agricultural Department, British Guiana, were among the many visitors during 1915-16.

METEOROLOGICAL RETURNS.**RAINFALL.**

The rainfall at the Botanic Gardens for 1915 amounted to 100.01 inches. The year is the wettest on record being 1.03 inches above the previous wettest year and 22 inches heavier than the mean rainfall over twenty-three years which is 77.97 inches.

The following table shows the monthly and annual rainfall at the Botanic Gardens from 1893 to 1915, a period of twenty-three years, and the accompanying diagram shows at a glance the fluctuation from year to year.

Another diagram shows the mean monthly rainfall over the same period. The exceptionally heavy rainfall of 15.75 inches which fell during April of 1915 has caused a slight rearrangement, March now appearing as the driest month; July continues to be the wettest month.

Following the above will be seen the table showing the monthly rainfall at the thirty-four recording stations located in different parts of the island.

From this table it will be observed that the mean rainfall for the thirty-four stations is 137.11 inches or 27.26 inches more than the precipitation during the previous year. By taking the island in districts we obtain the following returns: the eleven Leeward coast stations registered a mean of 103.31 inches; the three Windward coast stations averaged 150.31 inches; the thirteen Inland stations 169.76 inches, and the seven La Soye stations 123.92 inches.

ADDITIONAL METEOROLOGICAL OBSERVATIONS.

During the year the Gardens were furnished at the expense of the Imperial Government with a reliable Barometer, Anemometer, and a set of thermometers all corrected at the Meteorological Office, London. When these instruments are suitably housed daily readings will be taken and placed on record.

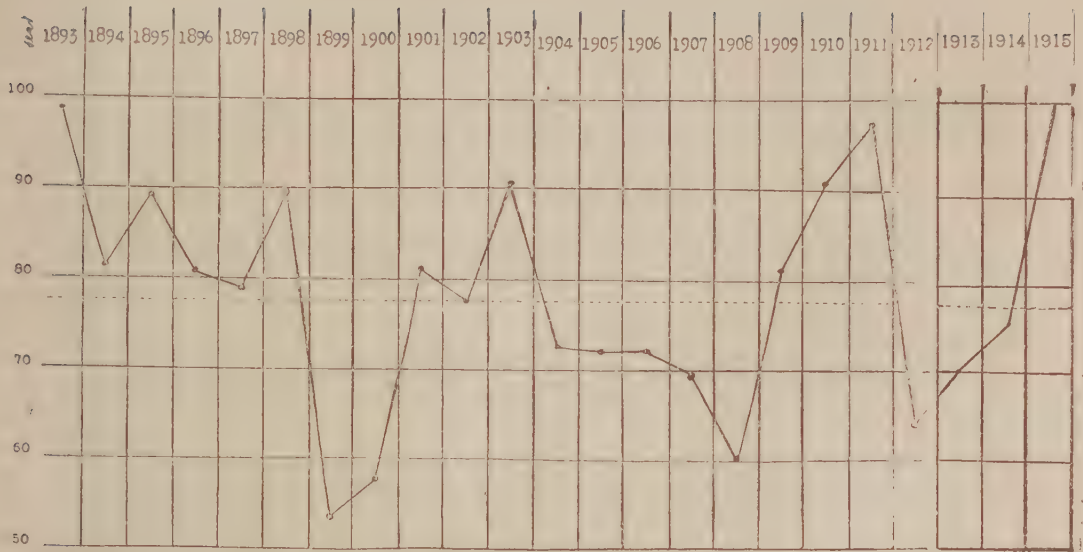


Diagram showing average annual rainfall in the Botanic Gardens, Dominica, for 23 years, 1893-1915.

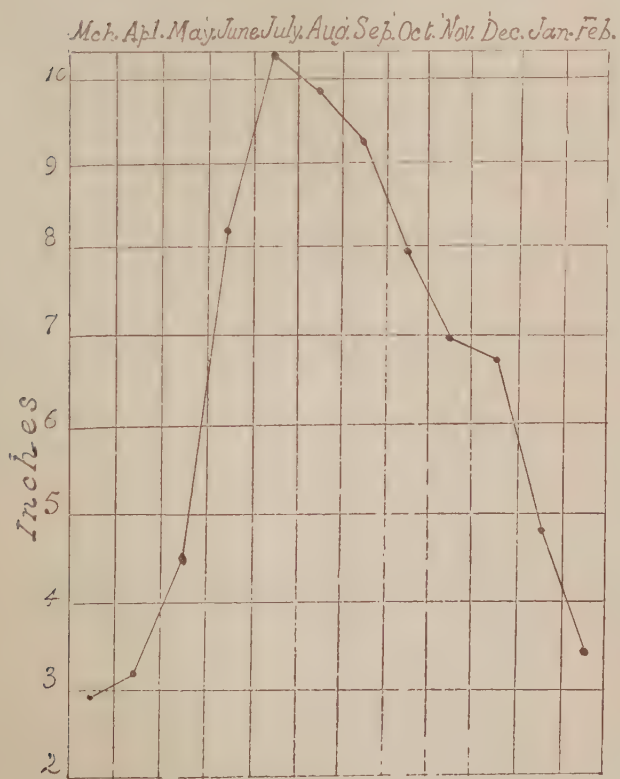


Diagram showing mean monthly rainfall, Botanic Gardens, Dominica, for 23 years, 1893-1915.

METEOROLOGICAL.

RAINFALL AT THE BOTANIC STATION, DOMINICA, 1893-1914.

Month.	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	Mean monthly rainfall.
January ..	3.62	10.20	4.08	5.52	2.60	3.00	6.78	2.25	4.52	2.01	3.10	7.92	3.86	3.74	4.48	1.56	2.30	5.20	11.46	8.21	7.48	3.22	1.76	1.73
February...	7.65	4.99	1.09	1.23	3.21	2.11	3.00	1.15	0.88	0.43	5.01	5.58	2.56	2.04	3.82	1.16	5.02	11.42	4.00	1.32	2.32	5.56	1.04	3.33
March ...	2.97	4.39	5.35	2.73	3.36	1.53	1.32	3.56	3.27	2.69	2.44	2.16	4.38	0.90	1.96	3.68	2.08	1.16	3.11	4.66	7.29	2.23	.84	2.96
April ...	1.71	2.33	2.92	1.27	1.39	0.75	0.60	1.29	0.25	2.80	0.57	1.61	1.90	3.18	2.66	3.08	8.12	2.86	5.90	3.38	1.57	6.45	15.75	3.21
May ...	5.15	3.09	10.08	6.12	12.75	1.19	1.76	7.62	2.05	6.86	2.41	1.58	1.32	3.78	1.61	2.21	1.92	7.39	11.16	1.56	3.46	2.58	3.65	4.55
June ...	16.12	8.22	3.19	8.23	6.50	11.78	7.23	5.59	12.18	12.80	9.02	6.00	5.51	9.16	5.51	6.16	9.00	11.26	6.51	5.11	3.19	7.27	9.17	8.20
July ...	3.67	8.62	7.13	11.88	8.80	11.75	10.08	10.50	22.96	9.71	8.91	10.38	6.10	10.10	8.00	9.22	9.86	12.60	8.08	5.83	7.57	11.83	14.81	10.63
August ...	11.86	5.81	9.67	7.67	8.87	16.35	6.32	7.31	13.53	7.41	18.41	7.69	11.18	7.30	7.40	9.41	13.12	10.22	11.43	1.88	10.93	3.98	11.71	9.91
September	11.15	8.22	17.42	6.47	4.51	7.89	7.04	5.28	5.86	8.62	9.69	11.32	8.92	10.88	11.60	7.52	6.14	8.90	15.31	3.32	8.39	7.71	11.36	9.29
October ..	8.91	14.41	11.32	3.93	8.42	7.97	1.81	6.60	4.81	5.75	12.73	10.21	9.10	8.12	7.80	5.12	13.10	3.82	7.06	7.26	10.40	5.13	8.41	7.92
November	3.18	6.14	11.21	16.81	7.81	6.55	5.02	3.49	6.43	11.20	4.17	3.13	5.48	9.58	5.98	1.46	4.36	5.10	6.91	11.20	4.28	9.44	10.05	6.95
December	10.61	1.99	5.66	6.60	10.55	5.86	2.19	3.68	4.32	7.16	11.23	4.81	5.72	2.94	8.42	7.80	5.82	7.50	7.14	6.66	2.72	9.70	8.10	6.68
Total ...	98.93	81.44	89.07	80.86	78.77	89.73	53.15	57.75	81.09	77.46	90.72	72.15	72.06	72.02	69.30	59.91	81.14	90.64	97.26	63.75	69.90	75.10	100.01	

RAINFALL RETURNS, DOMINICA, 1915.

Station.	January.	February.	March.	April.	May.	June.	July.	August.	Sept'ber.	October.	November.	December.	TOTAL.
Ancaster Park	3.96	2.53	.43	19.80	9.50	20.49	22.94	17.80	14.87	11.10	14.35	13.08	150.85
Antrim Valley	3.35	3.96	1.92	14.68	6.51	18.71	23.81	16.95	13.60	11.63	13.09	13.67	141.91
Batalie	0.21	0.00	0.29	13.77	1.88	9.45	8.99	5.91	13.21	6.23	7.43	3.20	70.60
Bellevue	7.55	9.27	1.37	27.44	12.70	19.91	26.6	22.36	19.14	15.82	11.10	12.51	188.53
Blenheim	5.11	13.81	1.21	33.35	9.42	14.81	12.44	9.91	10.66	11.33	14.28	7.59	143.95
Botanical Gardens	1.76	1.04	.84	13.75	3.65	9.17	14.81	14.74	11.36	8.41	10.05	8.40	100.01
Canefield	1.61	1.63	.62	13.62	5.53	10.26	17.18	12.09	11.78	7.07	9.97	8.31	99.67
Castleacre	2.97	3.34	1.23	19.0	9.90	16.62	23.75	13.70	17.96	12.57	16.52	14.87	152.63
Castle Bruce	10.72	14.91	8.70	25.91	15.16	11.22	23.70	17.66	9.58	8.86	17.67	14.05	151.98
Corlet	6.61	5.88	1.75	27.08	15.90	23.53	23.70	13.86	28.10	20.90	17.64	14.03	202.78
Everton	2.38	1.74	.93	11.79	6.10	12.99	15.70	13.86	14.88	9.39	13.62	10.10	113.78
Gl-an Manioc	14.95	22.58	2.84	40.15	23.51	30.23	37.60	29.54	33.40	18.05	16.75	20.21	289.81
Goodwill	1.55	1.18	.84	16.48	4.67	9.56	15.21	18.07	10.67	7.75	9.96	8.71	101.65
Governor	5.97	19.34	3.55	34.78	11.19	14.87	10.67	13.31	14.50	13.77	18.10	8.59	138.44
Hampstead	4.87	11.36	1.50	22.87	10.02	9.71	10.38	8.20	7.55	9.62	12.55	5.17	113.80
Hatton Garden	3.59	10.06	3.17	30.70	7.52	9.91	6.51	11.11	10.75	10.52	16.64	6.25	126.76
Hillsborough	1.54	.72	.67	1.59	6.79	1.62	13.43	10.56	11.38	5.57	9.81	6.79	93.27
Kinellan	4.13	4.58	1.01	24.79	10.69	20.92	22.95	20.56	16.70	12.73	15.44	16.06	170.57
La Haut	2.67	1.88	.84	13.50	7.34	11.83	15.32	14.73	14.61	8.85	12.02	9.38	112.97
Layou Park	8.79	5.51	1.01	21.37	13.79	21.43	29.89	24.57	16.83	8.03	13.42	4.87	169.51
Lisdara	12.42	8.26	1.46	20.81	8.25	15.74	19.31	18.48	18.42	19.56	16.45	8.29	167.45
Londonderry	4.19	7.43	2.23	21.46	9.09	8.10	7.12	10.55	7.66	10.63	14.81	5.36	108.93
Mantipo, Marigot	3.44	10.09	2.85	29.05	13.48	11.34	11.99	14.50	13.41	13.85	21.57	6.73	152.30
Melville Hall	8.35	9.21	2.95	23.03	9.21	9.79	8.08	12.53	11.09	12.38	16.49	5.22	128.33
Moore Park	5.70	11.87	3.10	29.00	7.36	13.04	9.99	11.83	7.89	10.50	13.91	6.82	131.01
Morne Bruce	2.55	1.51	.94	15.87	4.23	11.07	16.78	15.12	12.31	10.27	12.80	9.42	112.87
Picard	3.25	6.62	1.28	27.89	7.32	13.61	11.81	15.31	8.97	8.53	9.04	7.90	121.53
Pointe Mulatre	5.71	6.02	6.18	29.31	8.36	15.70	12.67	17.84	12.18	6.26	11.14	3.70	135.07
Rosalie	6.09	16.25	3.57	40.12	8.45	16.13	13.28	14.40	16.48	12.67	20.63	5.80	163.87
Shawford	6.93	1.30	0.00	13.61	11.83	21.49	29.94	15.07	18.22	10.13	21.51	9.90	159.95
Snug Corner	3.45	8.72	6.41	11.00	1.10	11.30	15.10	5.35	15.35	4.00	8.50	13.05	113.33
Soufriere	2.93	5.97	0.59	11.12	4.33	11.77	11.72	12.44	12.30	4.91	4.00	3.70	85.78
St. Aroment	2.36	1.74	1.18	17.27	6.48	12.29	17.59	14.05	14.68	10.13	11.79	11.80	121.34
Wall House	1.72	.83	.74	11.11	3.99	9.48	12.38	9.35	7.19	12.69	8.44	—	—
Woodford Hill	2.54	6.59	1.91	18.89	9.31	7.58	8.84	6.42	4.88	9.99	11.52	4.89	93.36

Mean Rainfall, 34 Stations
 11 Leeward Coast Stations 137.11 inches.
 3 Windward " 103.31 "
 13 Inland Stations 150.31 "
 7 La Soye " 169.76 "
 " " 123.92 "



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